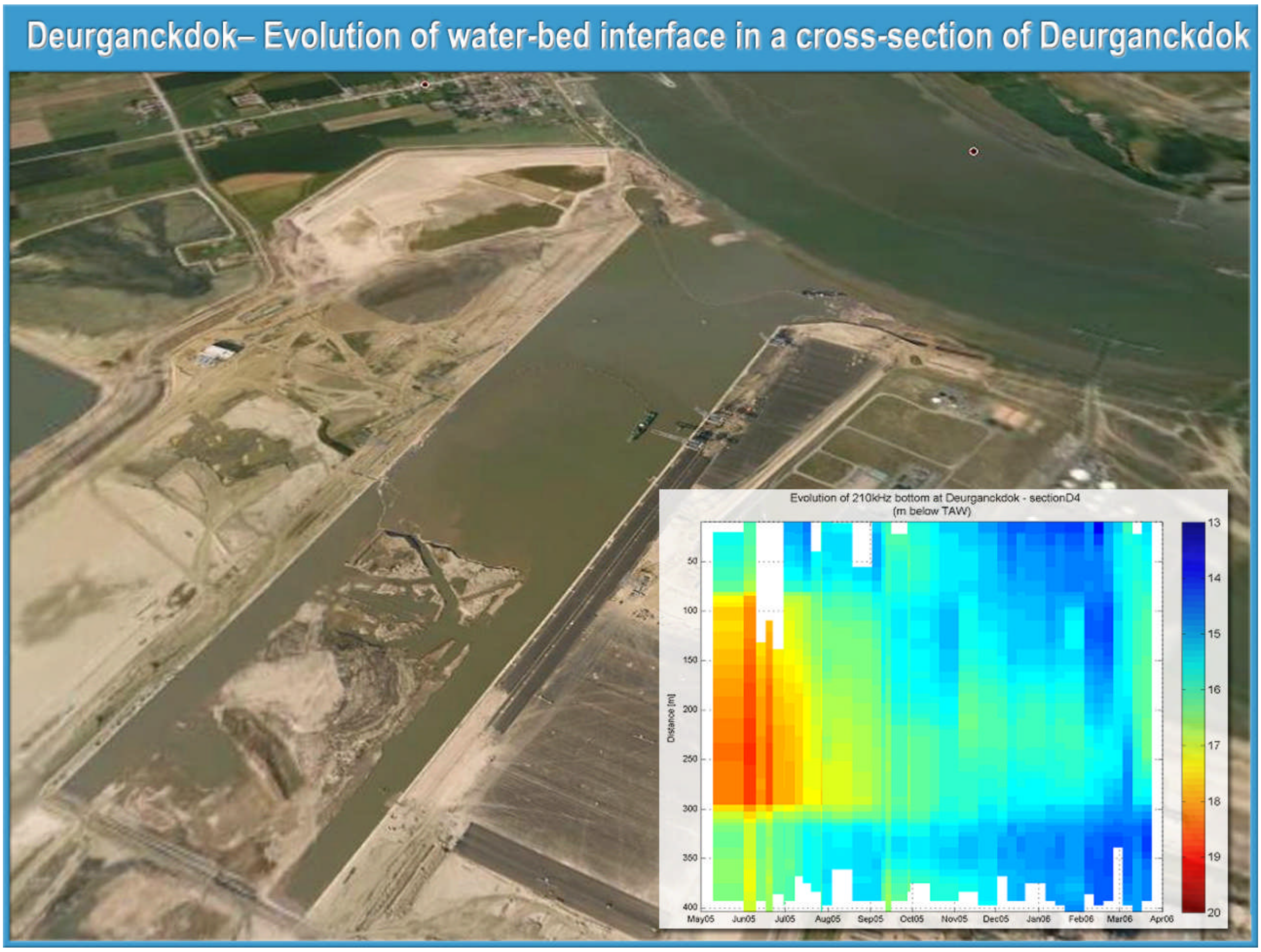
VLAAMSE OVERHEID

DEPARTEMENT MOBILITEIT EN OPENBARE WERKEN
WATERBOUWKUNDIG LABORATORIUM

Langdurige metingen Deurganckdok 2: Opvolging en analyse aanslibbing

Bestek 16EB/05/04



Deelrapport 1.11 : Sediment balans 01/07/2007 – 31/08/2007

Report 1.11 : Sediment balance 01/07/2007 – 31/08/2007

18 January 2008

I/RA/11283/07.082/MSA

i.s.m. en

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GLOSSARY

BIS	Dredging Information System used in the Lower Sea Scheldt
d	Density of dredged sediment [kg/dm³]
DGD	Deurganckdok
HCBS	High Concentration Benthic Suspensions
M	mass of dry solids [ton]
ρ_s	density of the solid minerals [kg/dm³]
ρ_w	density of clear water [kg/dm³]
t_{0d}	Reference situation for densimetric analysis (empty dock)
t_{0e}	Reference situation for volumetric analysis (24 March 2006)
TDS	Ton of dry solids [ton]
V	volume of dredged sediment [m³]

1. INTRODUCTION

1.1. The assignment

This report is part of the set of reports describing the results of the long-term measurements conducted in Deurganckdok aiming at the monitoring and analysis of silt accretion. This measurement campaign is an extension of the study "Extension of the study about density currents in the Beneden Zeeschelde" as part of the Long Term Vision for the Scheldt estuary. It is complementary to the study 'Field measurements high-concentration benthic suspensions (HCBS 2)'.

The terms of reference for this study were prepared by the 'Departement Mobiliteit en Openbare Werken van de Vlaamse Overheid, Afdeling Waterbouwkundig Laboratorium' (16EB/05/04). The repetition of this study was awarded to International Marine and Dredging Consultants NV in association with WL|Delft Hydraulics and Gems International on 10/01/2006. The project term was prolonged with an extra year from April 2007 till March 2008, 'Opvolging aanslibbing Deurganckdok'.

Waterbouwkundig Laboratorium– Cel Hydrometrie Schelde provided data on discharge, tide, salinity and turbidity along the river Scheldt and provided survey vessels for the long term and through tide measurements. Afdeling Maritieme Toegang provided maintenance dredging data. Agentschap voor Maritieme Dienstverlening en Kust – Afdeling Kust and Port of Antwerp provided depth sounding measurements.

The execution of the study involves a twofold assignment:

- Part 1: Setting up a sediment balance of Deurganckdok covering a period of one year, i.e. 04/2007 – 03/2008
- Part 2: An analysis of the parameters contributing to siltation in Deurganckdok

1.2. Purpose of the study

The Lower Sea Scheldt (Beneden Zeeschelde) is the stretch of the Scheldt estuary between the Belgium-Dutch border and Rupelmonde, where the entrance channels to the Antwerp sea locks are located. The navigation channel has a sandy bed, whereas the shallower areas (intertidal areas, mud flats, salt marshes) consist of sandy clay or even pure mud sometimes. This part of the Scheldt is characterized by large horizontal salinity gradients and the presence of a turbidity maximum with depth-averaged concentrations ranging from 50 to 500 mg/l at grain sizes of 60 - 100 μm. The salinity gradients generate significant density currents between the river and the entrance channels to the locks, causing large siltation rates. It is to be expected that in the near future also the Deurganckdok will suffer from such large siltation rates, which may double the amount of dredging material to be dumped in the Lower Sea Scheldt.

Results from the study may be interpreted by comparison with results from the HCBS and HCBS2 studies covering the whole Lower Sea Scheldt. These studies included through-tide measurement campaigns in the vicinity of Deurganckdok and long term measurements of turbidity and salinity in and near Deurganckdok.

The first part of the study focuses on obtaining a sediment balance of Deurganckdok. Aside from natural sedimentation, the sediment balance is influenced by the maintenance and capital dredging works. This involves sediment influx from capital dredging works in the Deurganckdok, and internal relocation and removal of sediment by maintenance dredging works. To compute a sediment balance an inventory of bathymetric data (depth soundings), density measurements of the deposited material and detailed information of capital and maintenance dredging works will be made up.

The second part of the study is to gain insight in the mechanisms causing siltation in Deurganckdok, it is important to follow the evolution of the parameters involved, and this on a long and short term basis (long term & through-tide measurements). Previous research has shown the importance of water exchange at the entrance of Deurganckdok is essential for understanding sediment transport between the dock and the Scheldt river.

1.3. Overview of the reports

1.3.1. Reports

Reports of the project 'Opvolging aanslibbing Deurganckdok 2' for the period April 2006 – March 2008 are summarized in Table 1-1.

Table 1-1: Overview of Deurganckdok Reports

Report	Description
Sediment Balance: Bathymetry surveys, Density measurements, Maintenance and construction dredging activities	
1.1	Sediment Balance: Three monthly report 1/4/2006 – 30/06/2006 (I/RA/11283/06.113/MSA)
1.2	Sediment Balance: Three monthly report 1/7/2006 – 30/09/2006 (I/RA/11283/06.114/MSA)
1.3	Sediment Balance: Three monthly report 1/10/2006 – 31/12/2006 (I/RA/11283/06.115/MSA)
1.4	Sediment Balance: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/06.116/MSA)
1.5	Annual Sediment Balance (I/RA/11283/06.117/MSA)
1.6	Sediment balance Bathymetry: 2005 – 3/2006 (I/RA/11283/06.118/MSA)
1.10	Sediment Balance: Three monthly report 1/4/2007 - 30/06/2007(I/RA/11283/07.081/MSA)
1.11	Sediment Balance: Two monthly report 1/7/2007 – 31/08/2007 (I/RA/11283/07.082/MSA)
1.12	Sediment Balance: Four monthly report 1/09/2007 – 31/12/2007 (I/RA/11283/07.083/MSA)
1.13	Sediment Balance: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/07.084/MSA)
1.14	Annual Sediment Balance (I/RA/11283/07.085/MSA)

Report	Description
Factors contributing to salt and sediment distribution in Deurganckdok: Salt-Silt (OBS3A) & Frame measurements, Through tide measurements (SiltProfiling & ADCP) & Calibrations	
2.1	Through tide measurement Siltprofiler 21/03/2006 Laure Marie (I/RA/11283/06.087/WGO)
2.2	Through tide measurement Siltprofiler 26/09/2006 Stream (I/RA/11283/06.068/MSA)
2.3	Through tide measurement Sediview spring tide 22/03/2006 Veremans (I/RA/11283/06.110/BDC)
2.4	Through tide measurement Sediview spring tide 27/09/2006 Parel 2 (I/RA/11283/06.119/MSA)
2.5	Through tide measurement Sediview neap tide (to be scheduled) (I/RA/11283/06.120/MSA)
2.6	Salinity-Silt distribution & Frame Measurements Deurganckdok 13/3/2006 – 31/05/2006 (I/RA/11283/06.121/MSA)
2.7	Salinity-Silt distribution & Frame Measurements Deurganckdok 15/07/2006 – 31/10/2006 (I/RA/11283/06.122/MSA)
2.8	Salinity-Silt distribution & Frame Measurements Deurganckdok 15/01/2007 – 15/03/2007 (I/RA/11283/06.123/MSA)
2.9	Calibration stationary equipment autumn (I/RA/11283/07.095/MSA)
2.10	Through tide measurement Siltprofiler winter (I/RA/11283/07.086/MSA)
2.11	Through tide measurement Salinity Profiling winter (I/RA/11283/07.087/MSA)
2.12	Through tide measurement Sediview winter (I/RA/11283/07.088/MSA)
2.13	Through tide measurement Sediview winter (I/RA/11283/07.089/MSA)
2.14	Through tide measurement Sediview winter (I/RA/11283/07.090/MSA)
2.15	Through tide measurement Siltprofiler (to be scheduled) (I/RA/11283/07.091/MSA)
2.16	Salt-Silt distribution Deurganckdok summer (21/6/2007 – 30/07/2007) (I/RA/11283/07.092/MSA)
2.17	Salt-Silt distribution & Frame Measurements Deurganckdok autumn (17/09/2007 - 10/12/2007) (I/RA/11283/07.093/MSA)
2.18	Salt-Silt distribution & Frame Measurements Deurganckdok winter (18/02/2008 - 31/3/2008) (I/RA/11283/07.094/MSA)
2.20	Calibration stationary & mobile equipment winter (I/RA/11283/07.096/MSA)
Boundary Conditions: Upriver Discharge, Salt concentration Scheldt, Bathymetric evolution in access channels, dredging activities in Lower Sea Scheldt and access channels	
3.1	Boundary conditions: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/06.127/MSA)
3.10	Boundary conditions: Three monthly report 1/4/2007 – 30/06/2007

Report	Description
	(I/RA/11283/07.097/MSA)
3.11	Boundary conditions: Three monthly report 1/7/2007 – 30/09/2007 (I/RA/11283/07.098/MSA)
3.12	Boundary conditions: Three monthly report 1/10/2007 – 31/12/2007 (I/RA/11283/07.099/MSA)
3.13	Boundary conditions: Three monthly report 1/1/2008 – 31/03/2008 (I/RA/11283/07.100/MSA)
3.14	Boundary conditions: Annual report (I/RA/11283/07.101/MSA)
Analysis	
4.1	Analysis of Siltation Processes and Factors (I/RA/11283/06.129/MSA)
4.10	Analysis of Siltation Processes and Factors (I/RA/11283/07.102/MSA)

1.3.2. Measurement actions

Following measurements have been carried out during the course of this project:

1. Monitoring upstream discharge in the Scheldt river
2. Monitoring Salt and sediment concentration in the Lower Sea Scheldt taken from on permanent data acquisition sites at Lillo, Oosterweel and up- and downstream of the Deurganckdok.
3. Long term measurement of salt distribution in Deurganckdok.
4. Long term measurement of sediment concentration in Deurganckdok
5. Monitoring near-bed processes in the central trench in the dock, near the entrance as well as near the landward end: near-bed turbidity, near-bed current velocity and bed elevation variations are measured from a fixed frame placed on the dock's bed.
6. Measurement of current, salt and sediment transport at the entrance of Deurganckdok for which ADCP backscatter intensity over a full cross section are calibrated with the Sediview procedure and vertical sediment and salt profiles are recorded with the SiltProfiler equipment
7. Through tide measurements of vertical sediment concentration profiles -including near bed highly concentrated suspensions- with the SiltProfiler equipment. Executed over a grid of points near the entrance of Deurganckdok.
8. Monitoring dredging activities at entrance channels towards the Kallo, Zandvliet and Berendrecht locks
9. Monitoring dredging and dumping activities in the Lower Sea Scheldt

In situ calibrations were conducted on several dates (15 March 2006; 14/04/2006; 23/06/2006; 18/09/2006) to calibrate all turbidity and conductivity sensors (IMDC, 2006f & IMDC, 2007l).

1.4. Structure of the report

This report is the sediment balance of the Deurganckdok for the period of 01/07/2007 to 31/08/2007. The first chapter comprises an introduction. The second chapter describes the project. Chapter 3 describes the methodology. The measurement results and processed data are presented in Chapter 4, whereas chapter 5 gives a preliminary analysis of the data.

2. SEDIMENTATION IN DEURGANCKDOK

2.1. Project Area: Deurganckdok

Deurganckdok is a tidal dock situated at the left bank in the Lower Sea Scheldt, between Liefkenshoek and Doel. Deurganckdok has the following characteristics:

1. The dock has a total length of 2750 m and is 450 m wide at the Scheldt end and 400 m wide at the inward end of the dock
2. The bottom of Deurganckdok is provided at a depth of –17m TAW in the transition zones between the quay walls and the central trench. The bottom in the central trench is designed at –19 m TAW.
3. The quay walls reach up to +9m TAW

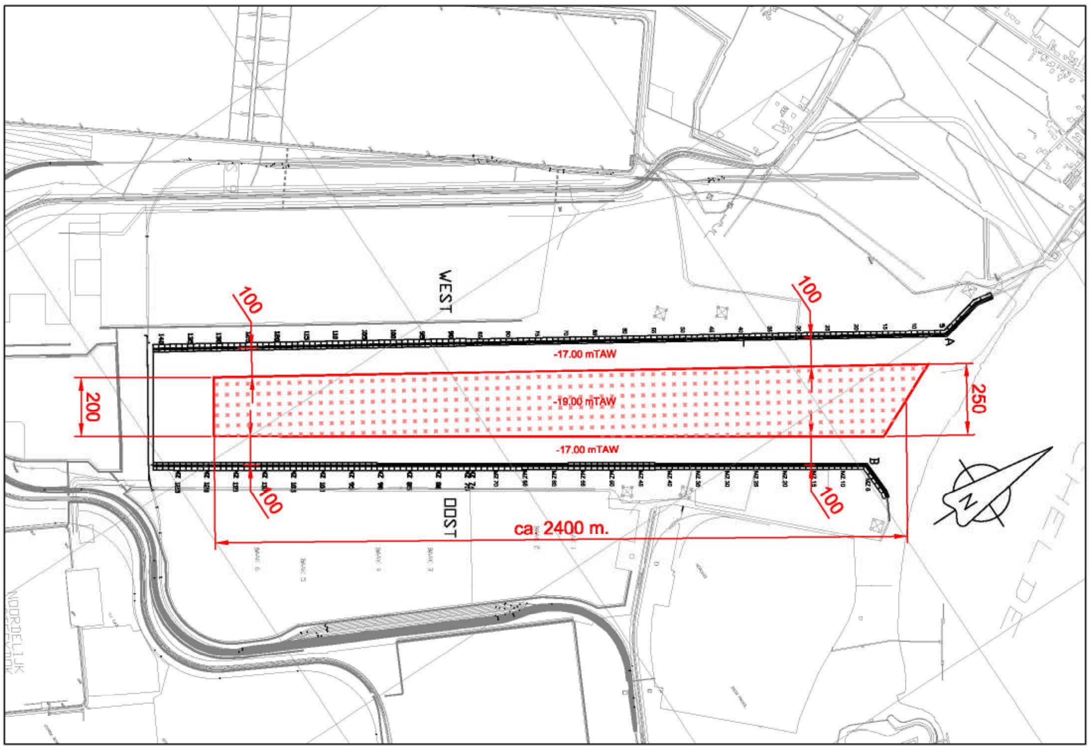

Figure 2-1: Overview of Deurganckdok

The dredging of the dock is performed in 3 phases. On 18 February 2005 the dike between the Scheldt and the Deurganckdok was breached. On 6 July 2005 Deurganckdok was officially opened. The second dredging phase was finalized a few weeks later. The first terminal operations have started since. In February 2007, the third dredging phase started and is planned to be finalised in 12 months time (by February 2008).

2.2. Overview of the studied parameters

The first part of the study aims at determining a sediment balance of Deurganckdok and the net influx of sediment. The sediment balance comprises a number of sediment transport modes: deposition, influx from capital dredging works, internal replacement and removal of sediments due to maintenance dredging (Figure 2-2).

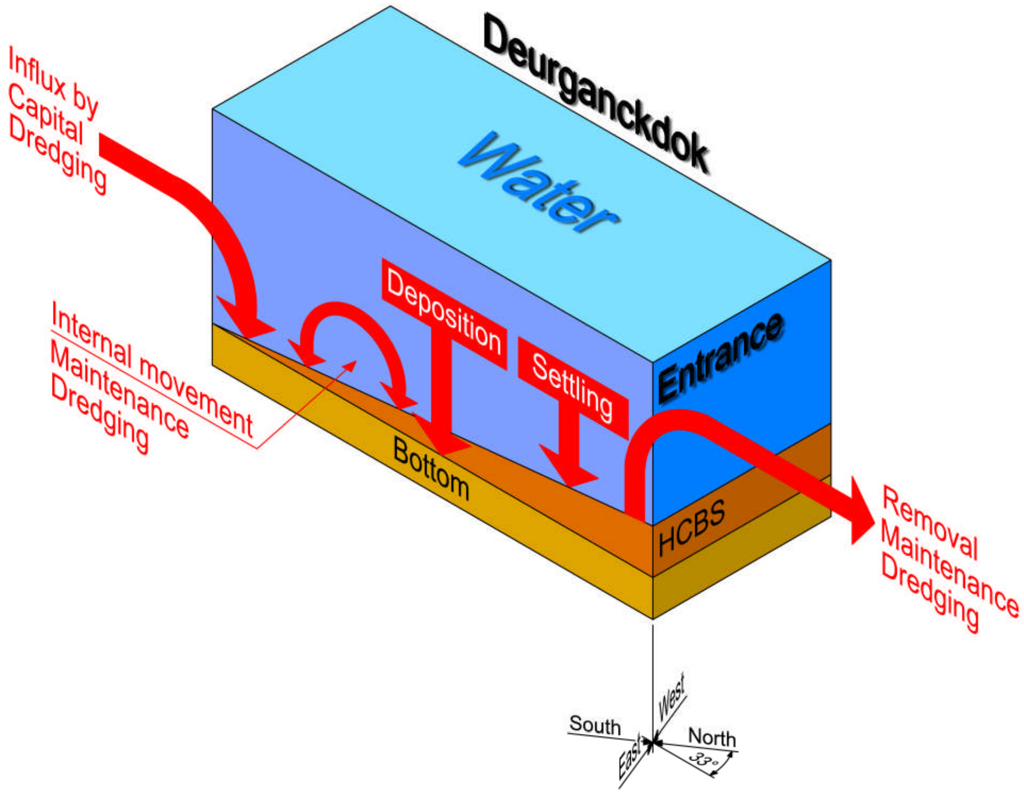

Figure 2-2: Elements of the sediment balance

A net deposition can be calculated from a comparison with a chosen initial condition t_0 (Figure 2-3). The mass of deposited sediment is determined from the integration of bed density profiles recorded at grid points covering the dock. Subtracting bed sediment mass at t_0 leads to the change in mass of sediments present in the dock (mass growth). Adding cumulated dry matter mass of dredged material removed since t_0 and subtracting any sediment influx due to capital dredging works leads to the total cumulated mass entered from the Scheldt river since t_0.

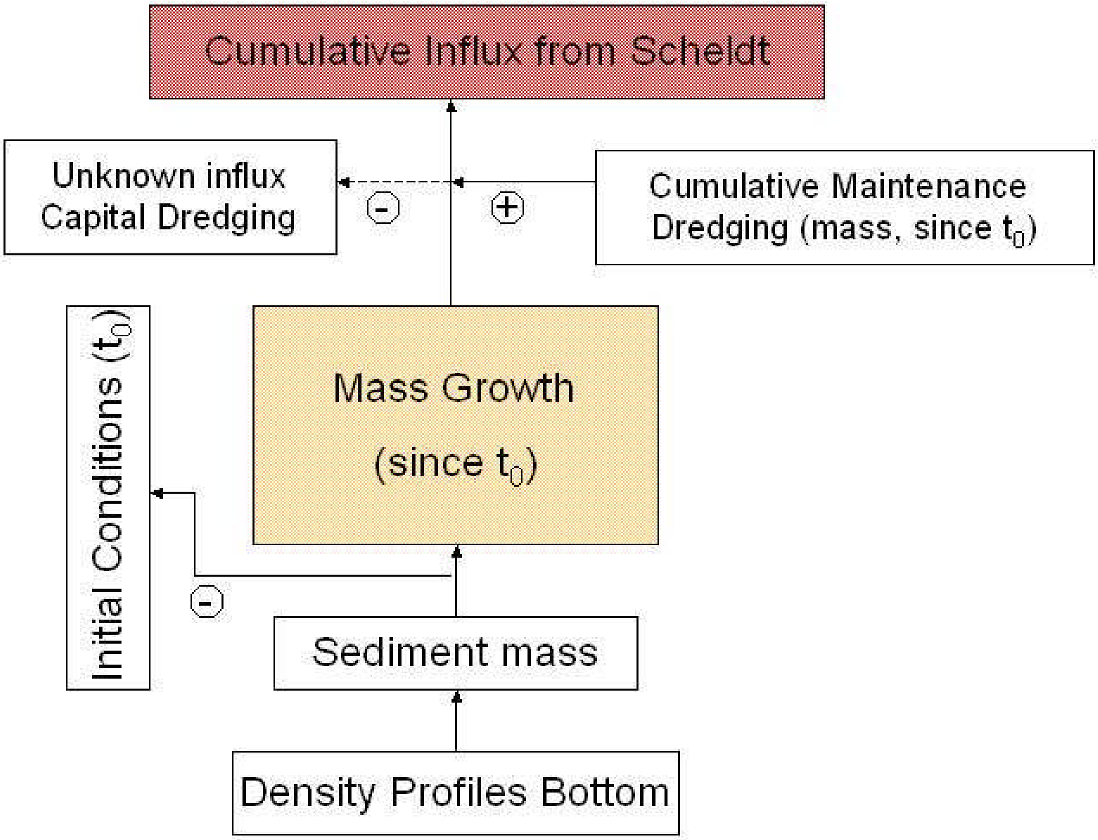

Figure 2-3: Determining a sediment balance

The main purpose of the second part of the study is to gain insight in the mechanisms causing siltation in Deurganckdok. The following mechanisms will be aimed at in this part of the study:

- Tidal prism, i.e. the extra volume in a water body due to high tide
- Vortex patterns due to passing tidal current
- Density currents due to salt gradient between the Scheldt river and the dock
- Density currents due to highly concentrated benthic suspensions

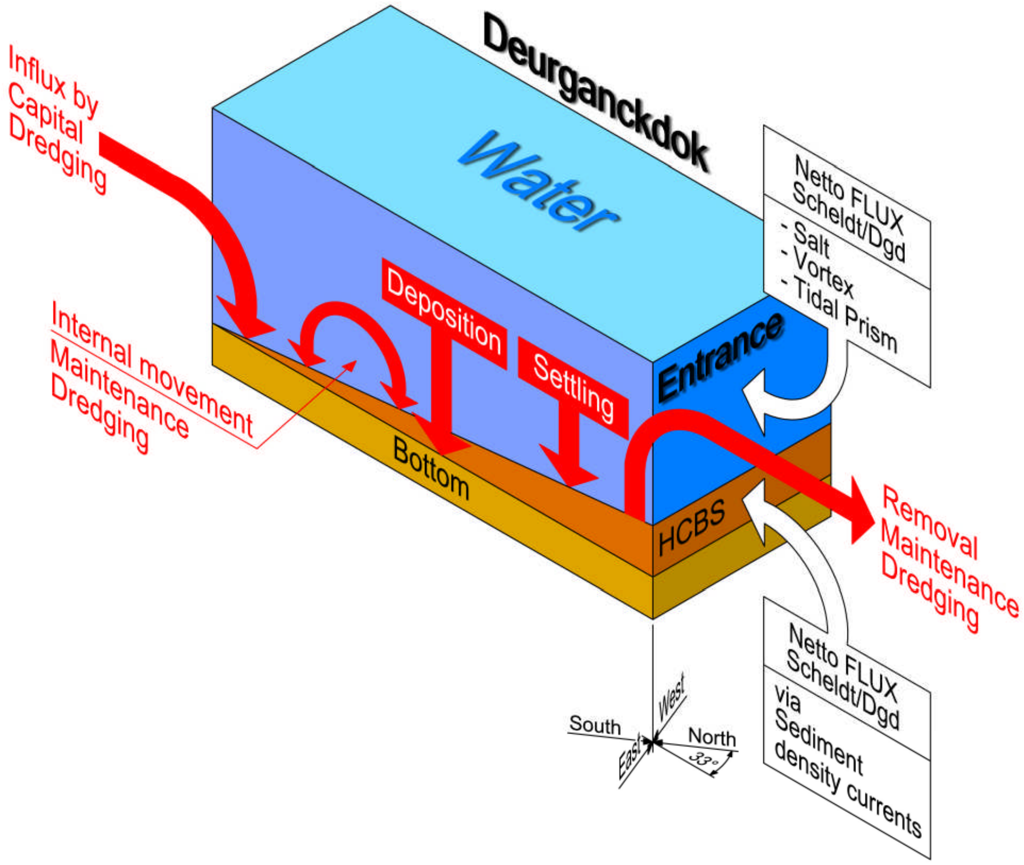

Figure 2-4: Transport mechanisms

These aspects of hydrodynamics and sediment transport have been landmark in determining the parameters to be measured during the project. Measurements will be focused on three types of timescales: one tidal cycle, one neap-spring cycle and seasonal variation within one year.

Following data are being collected to understand these mechanisms:

- Monitoring upstream discharge in the Scheldt river.
- Monitoring Salt and sediment concentration in the Lower Sea Scheldt at permanent measurement locations at Oosterweel, up- and downstream of the Deurganckdok.
- Long term measurement of salt and suspended sediment distribution in Deurganckdok.
- Monitoring near-bed processes (current velocity, turbidity, and bed elevation variations) in the central trench in the dock, near the entrance as well as near the current deflecting wall location.
- Dynamic measurements of current, salt and sediment transport at the entrance of Deurganckdok.
- Through tide measurements of vertical sediment concentration profiles -including near bed high concentrated benthic suspensions.
- Monitoring dredging activities at entrance channels towards the Kallo, Zandvliet and Berendrecht locks as well as dredging and dumping activities in the Lower Sea Scheldt.
- In situ calibrations were conducted on several dates to calibrate all turbidity and conductivity sensors.

3. MEASUREMENTS

3.1. Depth soundings

The client executes dual-frequency echo-sounder measurements every week to every three weeks. F. De Cock (Agentschap voor Maritieme Dienstverlening en Kust – Afdeling Kust) communicated that these measurements are carried out with a 210-33 kC Echo sounder using Qinsy software. The depth sounding measurements are executed in a grid configuration, consisting of sections perpendicular and parallel to the quay wall.

Table 3-1: Overview of the available depth soundings suitable for analysis 01/07/2007 – 31/08/2007

date	***type of measurement***	***signal***	***Source***
24/03/2006*	dual frequency 210-33 kHz	210	Afdeling Kust
27/07/2007	dual frequency 210-33 kHz	210	Afdeling Kust
31/08/2007	dual frequency 210-33 kHz	210	Afdeling Kust

*= reference situation depth soundings: t_{0e}

To calculate a sediment balance it is necessary to analyse the measurements in stationary situation, with no alteration in boundary conditions being dredging operations. Every period is characterized by a depth sounding measurement before (‘inpeiling’) and one after (‘uitpeiling’).

A number of analyses were done using the depth soundings in Table 3-1. The raw depth sounding data was processed in ESRI ArcGIS. Only the 210 kC signal is used in the following analyses as it gives an indication of the water-bed interface.

A reference level was chosen from all depth sounding measurements, effectively the earliest most complete measurement. This turned out to be the measurement on 24 March 2006. This will be considered as a reference situation, initial condition t_{0e}.

A number of analyses were performed in ArcGIS 9 and a Matlab environment to produce maps, figures and tables with relevant information concerning elevation, elevation changes and volumetric growth (§4.2 to §4.4).

3.2. Density measurements

3.2.1. Navitracker

Navitracker was used to perform density measurements. Density measurements are necessary to calculate a sediment balance of dry weight of sediment per surface unit.

The Navitracker is a patented system to measure the density of fluid mud suspensions, by means of a gamma-density meter. It has been used by the Flemish authorities over 20 years to determine the nautical bed for the port of Zeebrugge.

The Navitracker system can be operated by a computer controlled winch to tow it through the mud (horizontal mode). The Navitracker is equipped with the following sensors:

- The Gamma ray density sensor, mounted on a fork-like tow fish, gives density information.
- The depth sensor gives information of the depth of the sensor.
- The position of the fish is calculated out of the length of the winch cable. Together with the position of the tow fish, following the density level, a dual frequency echo sounder is used to map the hard bottom and the top of the mud. With a speed of 2 to 3 knots, large areas can be covered.

For these measurements the Navitracker was used in a vertical profiling mode, with the probe in vertical position in order to penetrate the soft bottom. The vertical density profiler is used to measure density in thick mud layers with high densities.

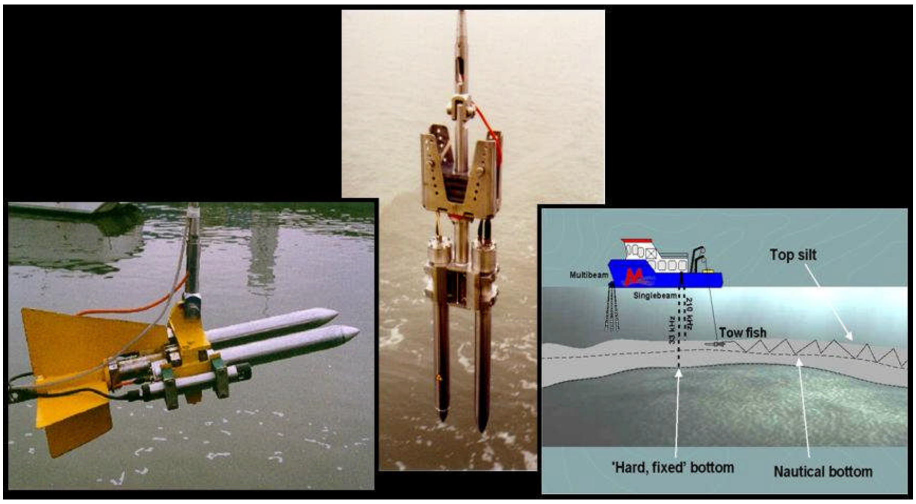

Figure 3-1: Navitracker

The Navitracker was calibrated in the laboratory for measuring high densities, formed by very dense water-mud mixtures. For this reason the Navitracker did not detect subtle variations in density caused by changes in salinity. The density deviated from 1.000 ton/m³ only in the presence of a high concentration of sediments.

The Navitracker has a sampling frequency of 10 measurements per second.

As a reference situation the empty dock will be used at the design depth. The design depths for the different zones are shown in Table 3-2. The different zones are described in §4.1.

Table 3-2: Reference Situation Density Measurements (t_{0d})

Zone	***Design Depth (mTAW)***
Central trench	-19
Berthing zones and transition zones to central trench	-17
Sill	-13.5
Transition sill to navigation channel	Not applicable

The resulting profiles were processed in a Matlab environment and visualized in Matlab and ESRI ArcGIS. Equal density layers were computed. Volume and density information was used to calculate masses of silt. All masses are given in ton of dry solids (TDS) characterized by a density of 2.65 kg/dm³. The water-bed interface is defined as the layer with a density of 1.03 kg/dm³.

3.2.2. SILAS in combination with Echotrac MKIII

Whereas the Navitracker performs local measurements of the density, an Echotrac MKIII echo sounder is used in combination with the SILAS software to determine horizons of equal density. The echo sounder transmits an acoustic signal of 33 and 210 kHz. The echo of the 33 kHz signal is automatically interpreted by the SILAS software and identifies various reflections horizons or layers and density levels.

The SILAS used calibration data originating from the Navitracker data set.

3.2.3. Performed density measurements

Density measurements were performed on 5-7 September 2007. However, because these measurements fit in a larger measurement campaign covering the period September – November 2007, they will be dealt with in Deelrapport 1.12: Sediment balance: 01/09/2007 – 31/12/2007 (IMDC, 2007h).

3.3. Maintenance Dredging Data

All maintenance dredging (except sweep beam) activities in Deurganckdok were collected in the BIS-system. This system gives a standardised output per week, that states the weight, volume and V'[1] removed/dumped in every 5*5m grid cell in the area. In case the density of the dredged sediment in the hopper bin is larger or equal to 1.6 kg/dm³, V' is equal to the volume in the bin. In case the density is smaller than 1.6 kg/dm³, V' is equal to the reduced volume which is defined as the volume the dredged sediment would have in case the density would be equal to 2 kg/dm³ (AWZ 2000). These dredged volumes are important to have an overall view on the sediment balance.

The available data on sweep beam activity is not collected in the BIS-system. However the mode of operation of the sweep beam is explained:

- On the sill (zone 1 & 2): the sediment is swept into the Lower Sea Scheldt
- Inside the dock: the sweep beam sweeps the berthing zones next to the quay walls and moves sediment into the central trench

Therefore an overview is given of where and when sweep beam dredger was working in Deurganckdok (DGD) or on the sill of Deurganckdok (sill DGD).

Table 3-3: Sweep beam Maintenance dredging activities in Deurganckdok and on the sill of Deurganckdok between July 2007 and August 2007 (source: Afdeling Maritieme Toegang)

From	Till	Duration (days)	Location
2/07/2007	2/07/2007	1	Sill DGD
12/07/2007	12/07/2007	1	Sill DGD
16/07/2007	16/07/2007	1	Sill DGD
24/07/2007	24/07/2007	1	Sill DGD
1/08/2007	1/08/2007	1	Sill DGD
6/08/2007	6/08/2007	1	Sill DGD
16/08/2007	17/08/2007	2	Sill DGD
20/08/2007	25/08/2007	5	Sill DGD + small part of commercial berths north and south

An overview of the total dredged mass in all zones (BIS data) is provided in APPENDIX D. The sweep beam tracks performed in each week are shown in APPENDIX E; only for 12/07/2007 and 01/08/2007 data were not available. The loggings of the sweep beam tracks show the position and depth of the rake. From the up-down position of the rake and the ship's direction, it is possible to identify whether the ship is sweeping sediment into the Scheldt or not. A thorough analysis of the obtained data revealed some problems though (IMDC, 2007d). For these reasons, the tracks will

[1] V' = Reduced Volume

not be applied as such in this study. Only the sweep beam locations will be utilised in a qualitative way.

3.4. Capital Dredging Data

In February 2007, the 3rd phase of the capital dredging works was initiated. Topographic measurements on a regular grid were supplied by the contractor in order to follow up the capital dredging progress. For the period 01/07/2007 till 31/08/2007 progress data is available for the following dates: 25 and 31 July, and 6 and 28 August 2007 and are shown in APPENDIX F. Note that the design depth of the first half of the dock is presented and not the actual bathymetry.

These data allow studying the progress of the dredging works. In reference to 14 February 2007, i.e. before capital dredging started, the volume of removed sediment is calculated. Further, the data also enable the computation of the dock's water storage capacity at low and high tide. In order to calculate the tide prism, the decadal tide data at Liefkenshoek was used, which resulted in a yearly averaged high and low tide level of 5.19 and 0.05 m TAW respectively.

4. SEDIMENT BALANCE ANALYSES

4.1. Project Area: (Sub)Zones and Sections

To calculate volumes and masses for the sediment balance of Deurganckdok it is necessary to subdivide it into 5 zones:

- Zone 1: Between the sill and the navigation channel in the Lower Sea Scheldt.
- Zone 2: Sill at entrance DGD designed at –13.5 m TAW.
- Zone 3: Central trench in DGD with a design depth at –19 m TAW (including slope to –17 m TAW)
- Zone 4: Transition between central trench and berthing zones with a design depth at –17.00 m TAW: on both (North (N) and South (Z)) sides of DGD (55 m wide).
- Zone 5: Berthing zones next to quay walls on both (North (N) and South (Z)) sides of DGD (40 m wide)

Zones 3, 4 and 5 are subdivided into subzones A, B, C, D and E. This is shown in Figure 4-1.

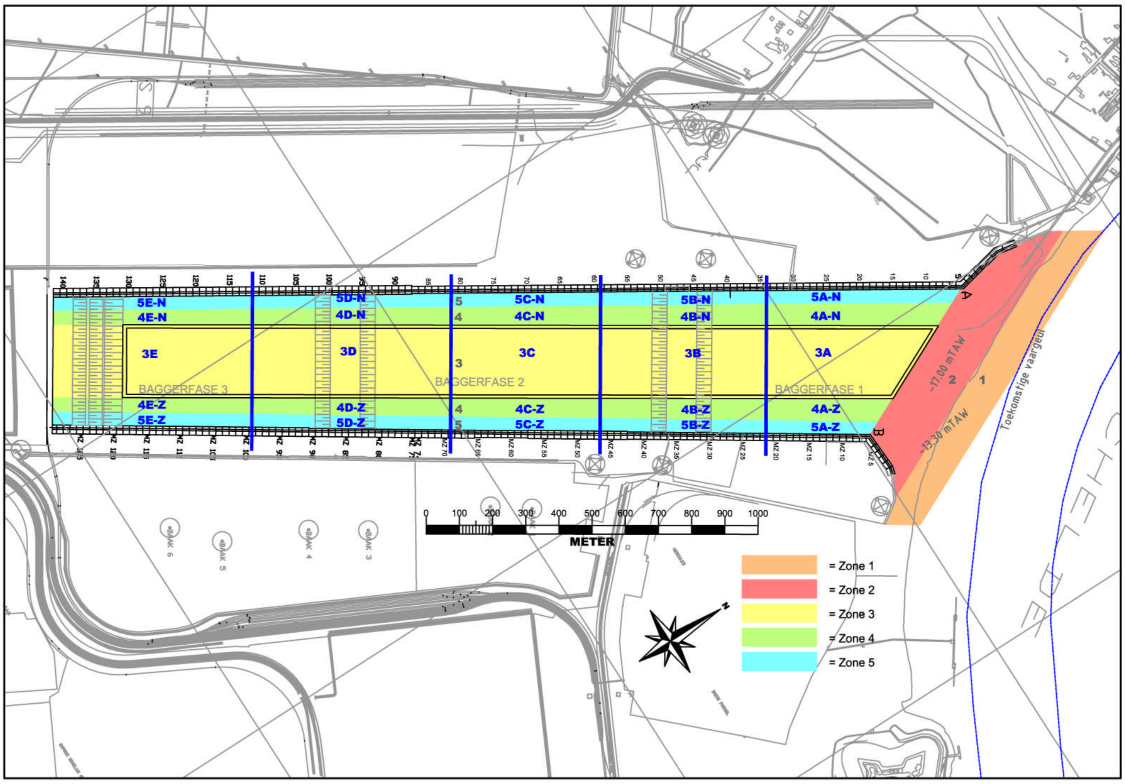

Figure 4-1: Deurganckdok: Zones and Subzones

Sections are defined for this whole area (Figure 4-2):

- D sections are oriented perpendicular to the quay walls inside the dock and parallel to the navigation channel outside the dock (sill and Scheldt). The origin of the sections is taken on the quay wall at the left bank (West side) looking outwards.
- L Sections are oriented along the centerline of the dock and run from the navigation channel towards the inland end of the dock, in anticipation of the realisation of the third phase of Deurganckdok. The origin is situated on the intersection between each L section and section D10.

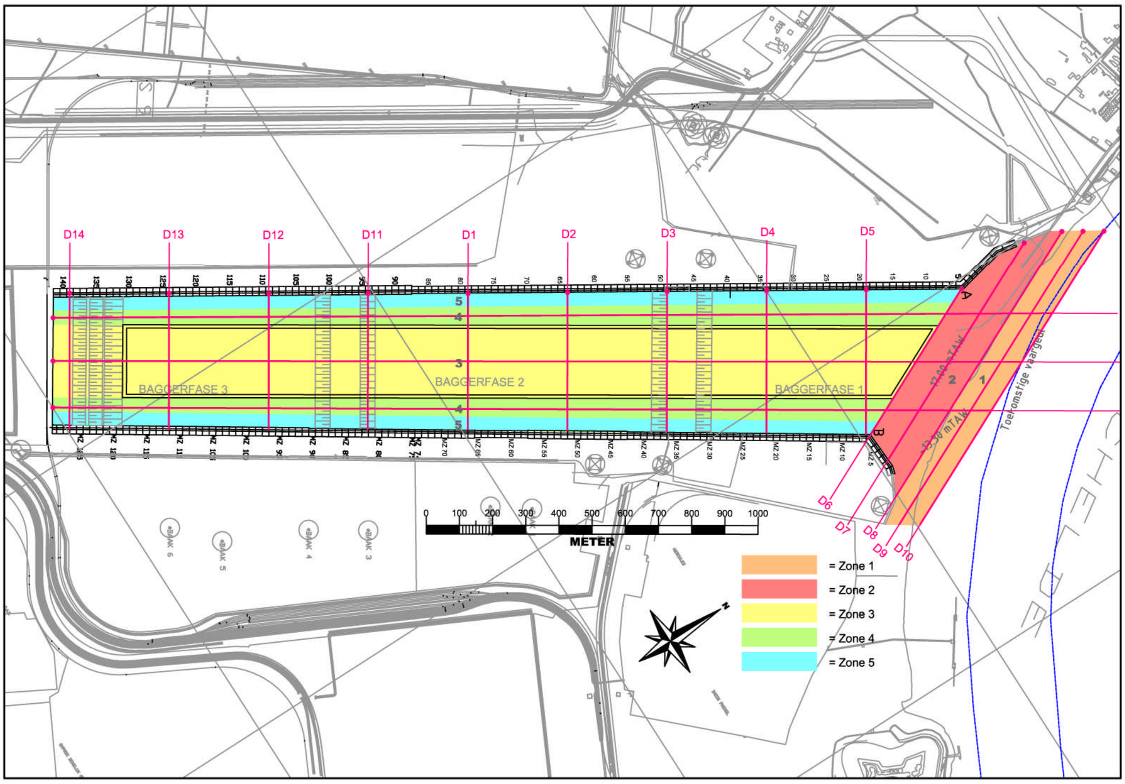

Figure 4-2: Deurganckdok: D and L Sections

The coordinates of these sections are given in Table 4-1.

Table 4-1: Coordinates of Sections [UTM ED50]

Name	**Origin**		**End**	
	Easting	**Northing**	**Easting**	**Northing**
D Sections				
D1	587773	5683253	588123	5683037
D2	587929	5683510	588283	5683290
D3	588084	5683767	588444	5683544
D4	588239	5684023	588604	5683797
D5	588394	5684280	588765	5684051
D6	588542	5684526	588772	5684062
D7	588521	5684761	588864	5684068
D8	588552	5684875	588972	5684027
D9	588585	5684930	589047	5683994
D10	588617	5684984	589081	5684047
D11	587615	5682997	587962	5682783
D12	587459	5682742	587802	5682529
D13	587300	5682487	587642	5682276
D14	587143	5682232	587482	5682023
L Sections				
L1	588748	5684720	587180	5682151
L2	588825	5684565	587290	5682082
L3	588901	5684410	587409	5682007

4.2. Depth of the water-bed interface (210 kC)

This is shown as a GIS grid map generated directly from the depth sounding data and is shown in APPENDIX A. An example is shown in Figure 4-3.

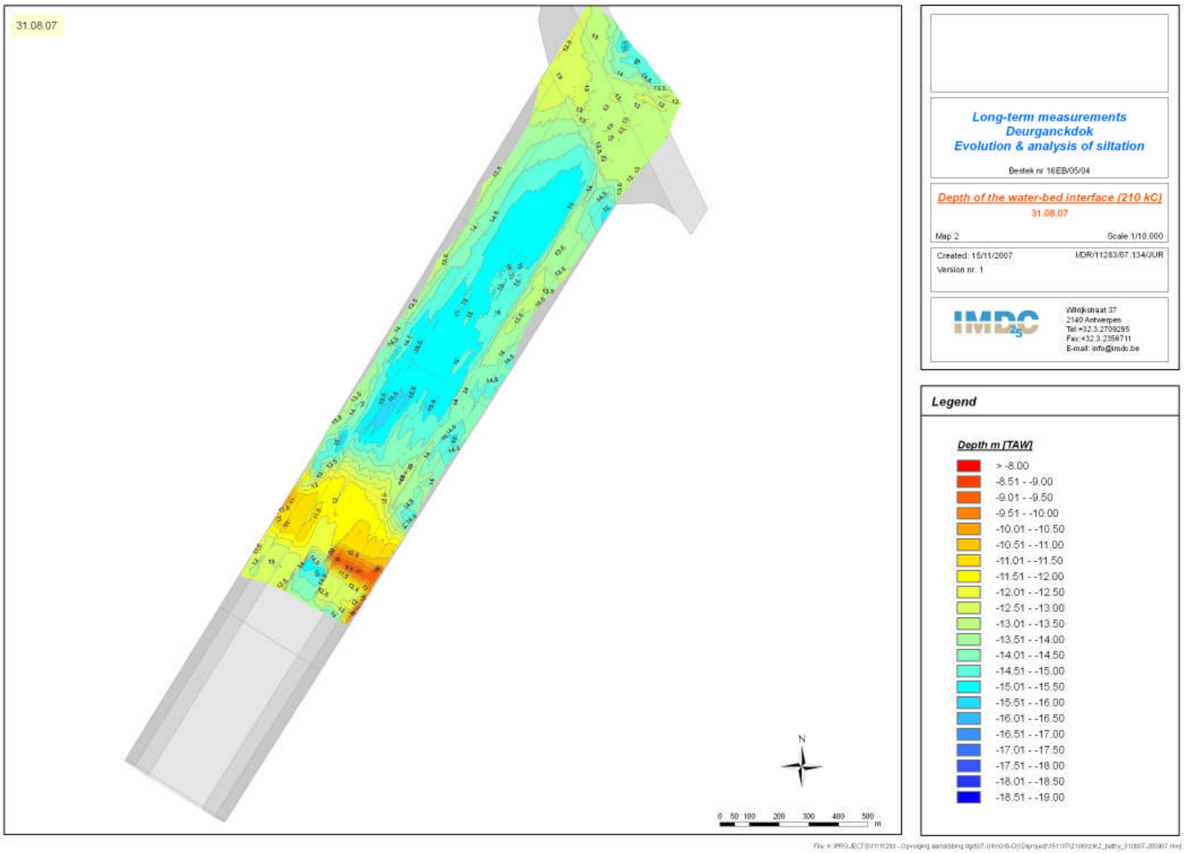

Figure 4-3: Example of a map showing depth of water-bed interface (210 kC) for 31/08/07

4.3. Evolution of water-bed interface (210 kC)

GIS grid maps show the difference charts for every depth sounding in relation to the reference situation (t_{0e}) and to the previous depth sounding (right). An example is shown in Figure 4-4.

The difference in depth between subsequent depth soundings for 210 kC measurements is also shown for all predefined sections. Graphs show a colour plot with Time in the X-axis, Distance to origin of section in the Y-axis and the depth of the top layer [m TAW] as a colour plot.

The origin for de the D sections is the northern quay wall. The origin of the L sections is the intersection between the L section with the Scheldt edge of zone 1. An example for sections is shown in Figure 4-5. The description of the sections is given in § 4.1.

Maps and graphs are shown in APPENDIX B.

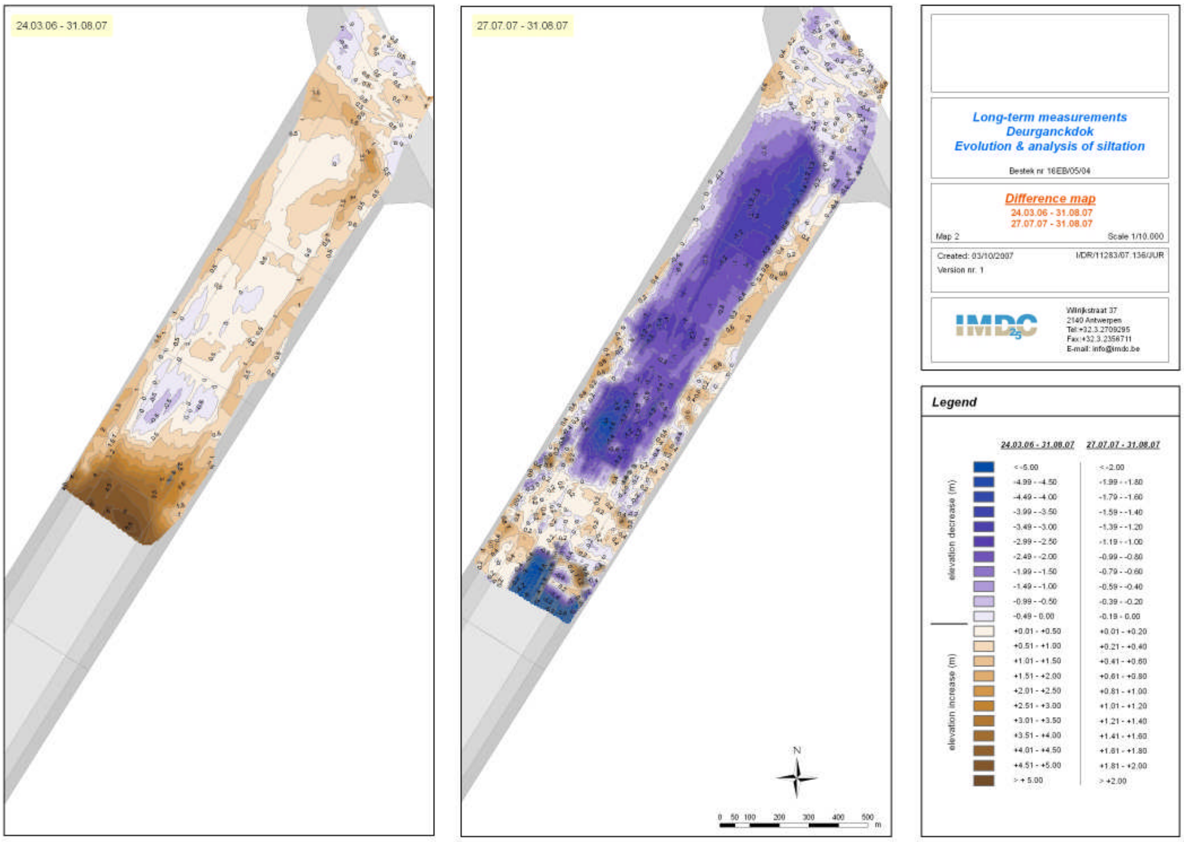

Figure 4-4: Difference charts of the depth sounding on 31/08/07: in reference to t_{0e} (left), and to the previous measurement (right) on 27/07/07

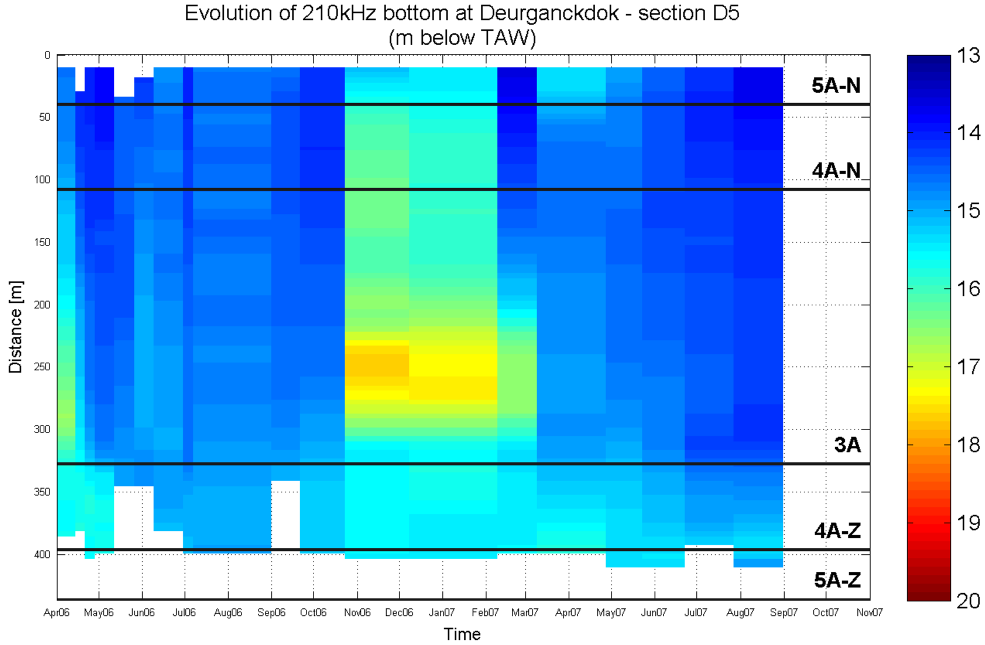

Figure 4-5: Graph of Evolution of the water-bed interface (210 kC) for section D5

4.4. Volumetric siltation rates [cm/day] in different zones and sections

A table with monthly average siltation rates for all (sub)zones is also given in APPENDIX C.

Graphs in APPENDIX C show two parameters:

- Average siltation rates [cm/day]: The average siltation rate is the difference in the depth of the water-bed interface and is calculated only for those zones and subzones that have at least a 50% surface area overlap between two subsequent depth soundings. This is done for all successive depth soundings. For each month an average siltation rate is calculated this way. It is shown in the plots as a bar and is positive for sedimentation and negative for erosion or removal.
- Cumulative bed level change [m]: an initial situation (t_0) is used as baseline. Starting from this reference level the evolution of the average bed level elevation is shown for the particular (sub)zone.

Dredging events from the BIS system are marked on each of these graphs. This is computed for all zones, subzones, sections and Deurganckdok as a whole. As an example we show siltation rate and cumulative bed level change for zone 3a in Figure 4-6.

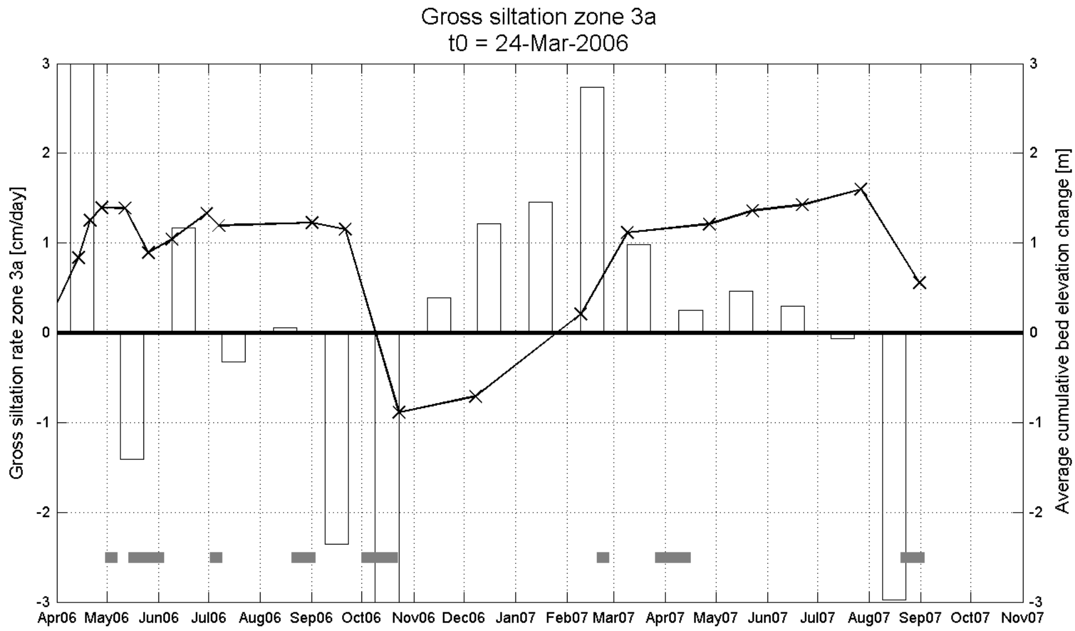

Figure 4-6: Volumetric siltation rate for zone 3a

4.5. Capital dredging works

Capital dredging data is used to compute the time evolution of the volume of dredged sediment. The volumetric change has been calculated in reference to 14 February 2007.

To compute the tide prism, it is necessary to have an idea about the total dock volume available for water storage during high and low tide. Therefore, the decadal tide data at Liefkenshoek was used and resulted in a yearly averaged high and low tide level of 5.19 and 0.05 m TAW respectively (AMT, 2003). For the operational part of the Deurganckdok (see Figure 4-7), the design depth was used, whereas for the remainder of the dock the topographic measurements were applied. An example of such a data set is shown in Figure 4-8.

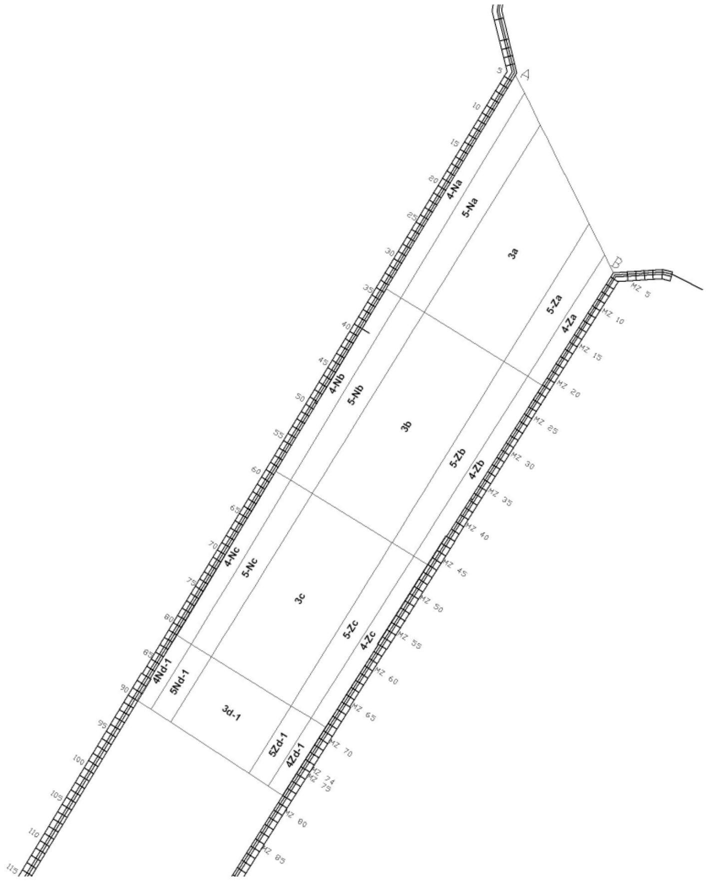

Figure 4-7: Operational part of Deurganckdok at the start of the 3rd phase of capital dredging works (Feb. 2007)

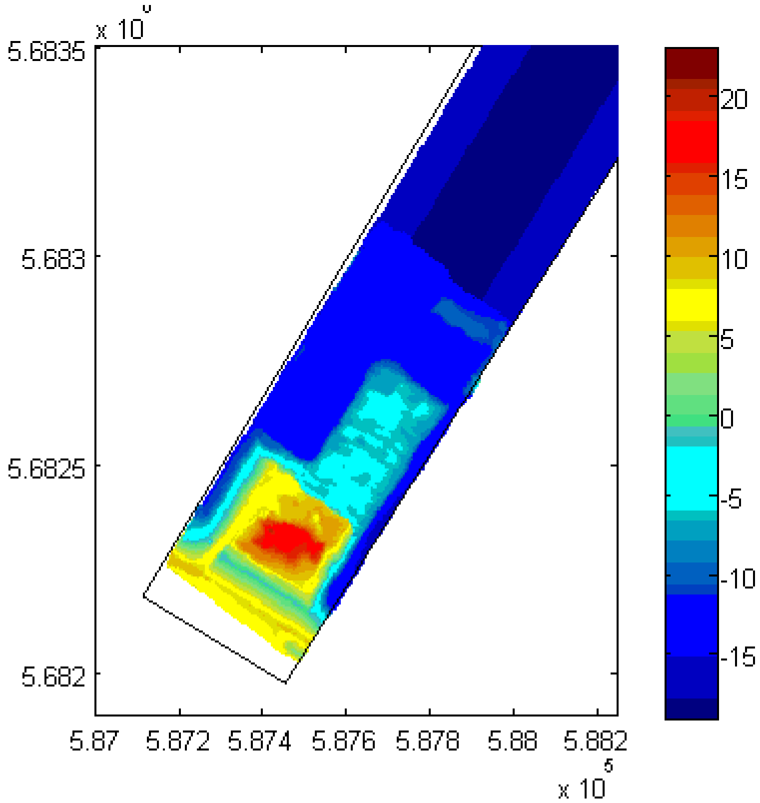

Figure 4-8: Depth of capital dredging (and design depth) on 25/07/2007

5. PRELIMINARY ANALYSIS OF THE DATA

Depth sounding data is processed to show the evolution of the average sediment volume per unit of surface, i.e. the average evolution of bed level as detected by a 210kHz sounder. If more than 50% of the area of a (sub)zone is covered, an average siltation rate is calculated. For the period of July – August 2007, depth soundings were performed on 27 July and 31 August. During these measurements, an adequate coverage was obtained during depth soundings, except for zone 1 and zones 5A-Z, 5B-Z, 5C-Z, 5B-N and all subzones of D and E.

BIS data revealed that hopper maintenance dredging occurred twice in August and lasted two consecutive weeks. A total amount of dredged solids of 120 10^3 TDS was dredged. The amount was *grosso modo* equally spread over these two weeks. 25% of the total dredged mass is to be found in each zone 1 and 2, whereas 18% was retrieved from zone 3A. Slightly more than 6% originated from zones 3B and 4A-N; all other zones were dredged less than 5% of the total dredged mass.

Sweep beam maintenance dredging generally occurred on the sill. Note that the sweep beam actions were followed by hopper maintenance dredging to remove the solids in the central trench (being moved there by the sweep beam) within a period of up to 5 days.

The bathymetric measurements on 27 July show very similar results in comparison to the last observation of the previous report, i.e. June 22, 2007. Only some bed level increase can be seen in zones 3A, 4A-N, 5A-N, 4B-N and 5B-N. These observations are consistent with the fact that no maintenance dredging occurred in this period and, therefore, can be attributed to natural siltation processes. Instead, the bathymetric recordings on 31 August indicate major dredging effects. Especially the central trench and the southern part of the sill are intensively dredged, resulting in large bed level decreases.

From the temporal evolution of the bathymetry, and the calculated siltation rates too (although siltation rates are sometimes contradictory to bathymetric observations due to interpolation assumptions in order to calculate the monthly averaged rates), the bed elevation in the central trench increased at *grosso modo* the same rate since the last maintenance dredging operation in April 2007. Obviously, this bed level increase was reversed to a decrease due to dredging operations in August. The same observation counts at the northern zones 4, except for zone 4C-N where the bed level steadily decreases from June on. The southern zones 4, in general, show an increase of bed level although maintenance dredging locally occurred.
Averaged over zones A, B and C (see Figure 5-1), the bed level increase in July is similar to the previous months and can be characterised by a rate in the order of 0.3 cm/day.

A table with monthly-averaged siltation rates for all cross sections, longitudinal sections and subzones is given in a table in APPENDIX C.

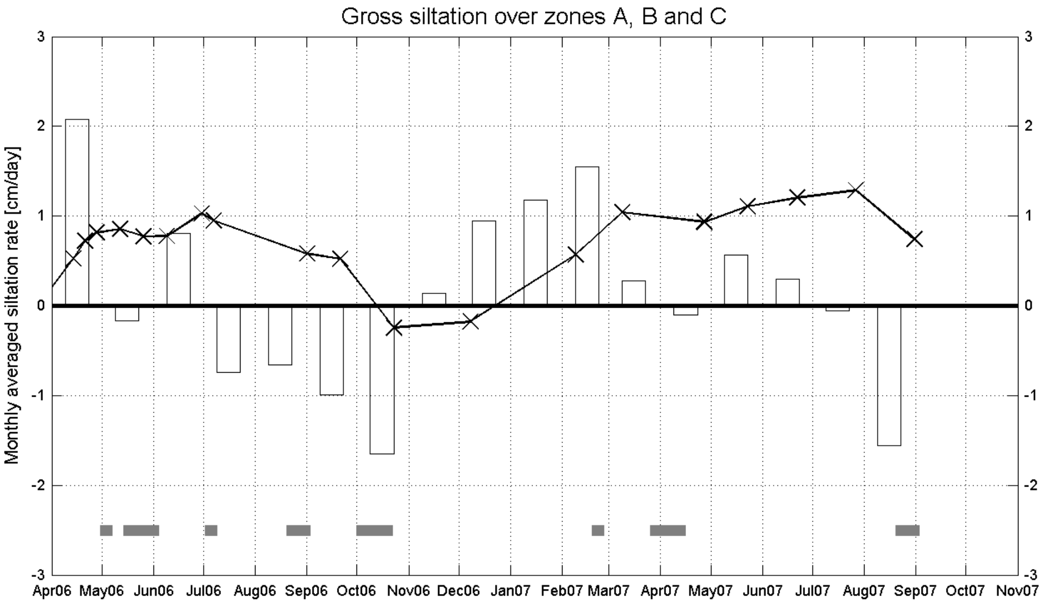

Figure 5-1: Monthly averaged siltation rate for the present measurement period (April 2006 - August 2007)(BOTTOM) (t_{0e} : 24/03/2006)

Capital dredging started in February 2007 in order to deepen the remainder of the Deurganckdok to its design depth. In this respect, Table 5-1 summarizes the time evolution of removed sediment by capital dredging. From the table, it is clear that more than 0.5 million m³ sediment/month is dredged in the period July-August 2007.
Note however that 25 July is characterised by a larger dredged volume in comparison with 31 July, in reference to 14 February 2007. Obviously, this observation seems doubtful because it reflects an accumulation of sediment volume instead of dredging. However, when investigating the bathymetry of the capital dredging area it becomes clear that some areas show a lower bed level in comparison to 31 July (see Figure 5-2). These rather deep spots, also in comparison to the operational part of the dock, are expected to be rapidly filled up with sediments resulting in the artificially lower dredged volume on 31 July in Table 5-1.

Whereas the period April-June led to a tide prism increase of 375.4 10³ m³, the months of July and August led to an increase of 238 10³ m³ (Table 5-2).

Table 5-1: Calculated cumulative volume removed by capital dredging in reference to 14 February 2007

Date	***Dredged volume from capital dredging works*** **(reference time: 14 Feb. 2007)** ***(10^3 m^3)***
03/04/2007	1571.5
08/05/2007	2392.6
18/06/2007	3229.5
25/07/2007	3658.0
31/07/2007	3574.3
06/08/2007	3720.0
28/08/2007	4261.8

Table 5-2: Calculated tide prism during capital dredging operations at Deurganckdok

Date	***Dock volume at high tide (10^3 m^3)***	***Dock volume at low tide (10^3 m^3)***	***Tide prism (10^3 m^3)***
start 3rd phase	15553.1	12111.7	3441.4
26/03/2007	17124.9	13642.2	4482.7
03/04/2007	18399.4	13773.1	4626.4
08/05/2007	19084.7	14363.8	4720.8
18/06/2007	19681.4	14823.3	4858.1
25/07/2007	19892.0	14954.2	4938.7
31/07/2007	19870.7	14883.6	4987.1
06/08/2007	19970.7	14933.3	5037.5
28/08/2007	20476.1	15378.0	5096.1

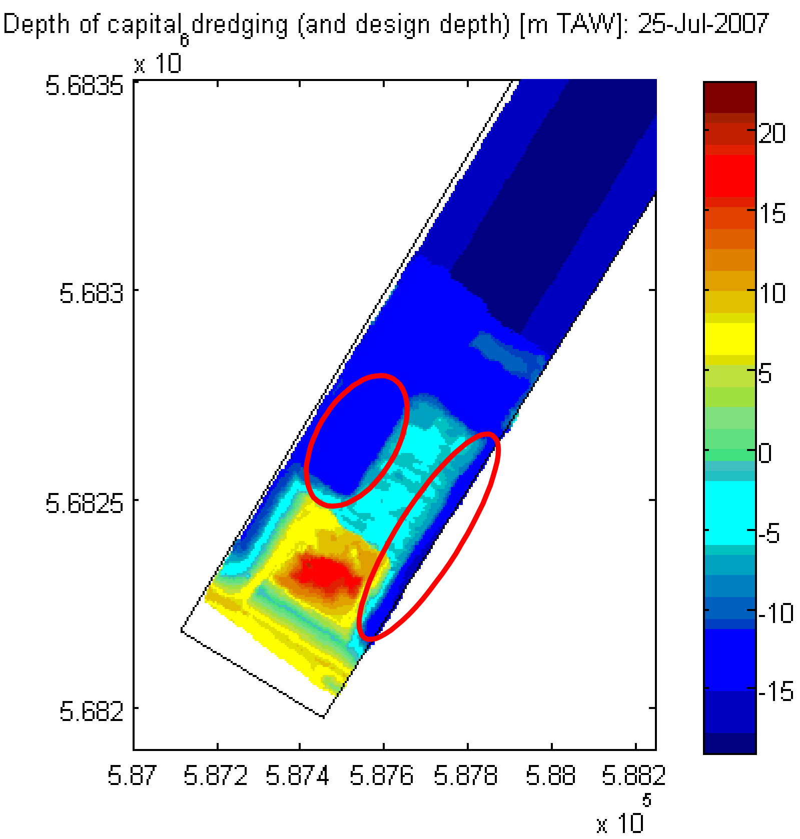

Figure 5-2: Depth in the area of capital dredging works on 25 July 2007 (for the operational part of the dock, the design depth is showed); the areas with lower bed levels as compared to 31 July 2007 are delineated by a red line

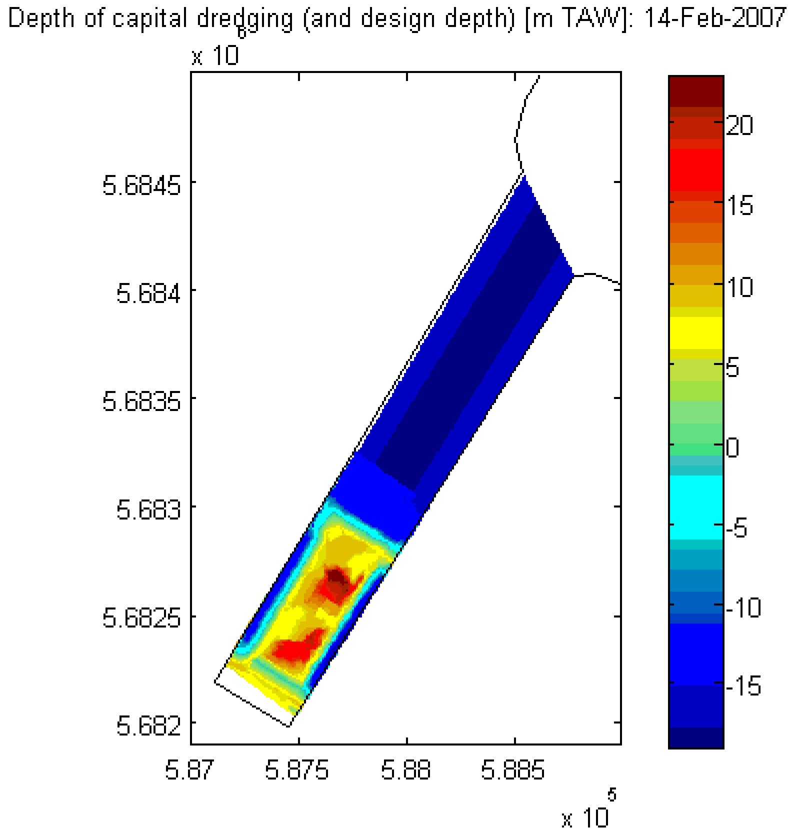

Figure 5-3: Depth before capital dredging works started from the dockside in February 2007 (for the operational part of the dock, the design depth is showed)

6. REFERENCES

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IMDC (2006b) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.1 Through tide measurement SiltProfiler 21/03/2006 Laure Marie (I/RA/11283/06.087/WGO).

IMDC (2006c) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.3 Through tide measurement Sediview spring tide 22/03/2006 Veremans (I/RA/11283/06.110/BDC)

IMDC (2006d) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.4 Through tide measurement Sediview spring tide 27/09/2006 Parel 2 (I/RA/11283/06.119/MSA).

IMDC (2006e) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.6 Salt-Silt distribution & Frame Measurements Deurganckdok 13/3/2006 – 31/05/2006 (I/RA/11283/06.121/MSA).

IMDC (2007a) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.1 Sediment Balance: Three monthly report 1/4/2006 – 30/06/2006 (I/RA/11283/06.113/MSA)

IMDC (2007b) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.2 Sediment Balance: Three monthly report 1/7/2006 – 30/09/2006 (I/RA/11283/06.114/MSA)

IMDC (2007c) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.3 Sediment Balance: Three monthly report 1/10/2006 – 31/12/2006 (I/RA/11283/06.115/MSA)

IMDC (2007d) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.4 Sediment Balance: Three monthly report 1/1/2007 – 31/03/2007 (I/RA/11283/06.116/MSA)

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IMDC (2007f) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.2 Through tide measurement SiltProfiler 26/09/2006 Stream (I/RA/11283/06.068/MSA)

IMDC (2007g) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.5 Through tide measurement Sediview neap tide (to be scheduled) (I/RA/11283/06.120/MSA)

IMDC (2007h) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 2.7 Salt-Silt distribution & Frame Measurements Deurganckdok 15/07/2006 – 31/10/2006 (I/RA/11283/06.122/MSA)

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IMDC (2007k) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 3.2 Boundary condtions: Annual report (I/RA/11283/06.128/MSA)

IMDC (2007g) Uitbreiding studie densiteitsstromingen in de Beneden Zeeschelde in het kader van LTV Meetcampagne naar hooggeconcentreerde slibsuspensies Deelrapport 6.2 Summer Calibration and Final Report (I/RA/11291/06.093/MSA)

IMDC (2007h) Langdurige metingen Deurganckdok: Opvolging en analyse aanslibbing. Deelrapport 1.12 Sediment balance: 01/09/2007 – 31/12/2007 (I/RA/11283/07.083/MSA)

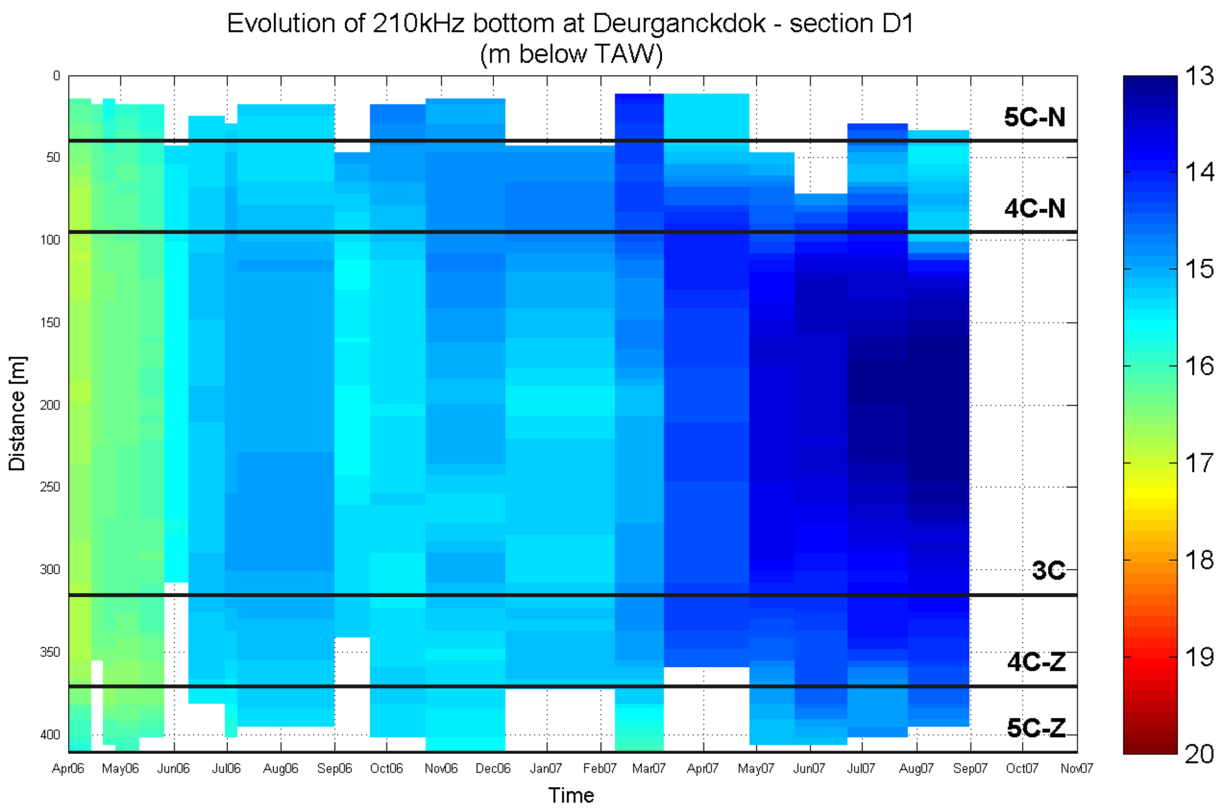
APPENDIX A. DEPTH OF THE WATER-BED INTERFACE (210 KC)

APPENDIX B. EVOLUTION OF DEPTH OF WATER-BED INTERFACE (210 KC)

B.1 Difference maps

B.2 Bed elevation evolution per section

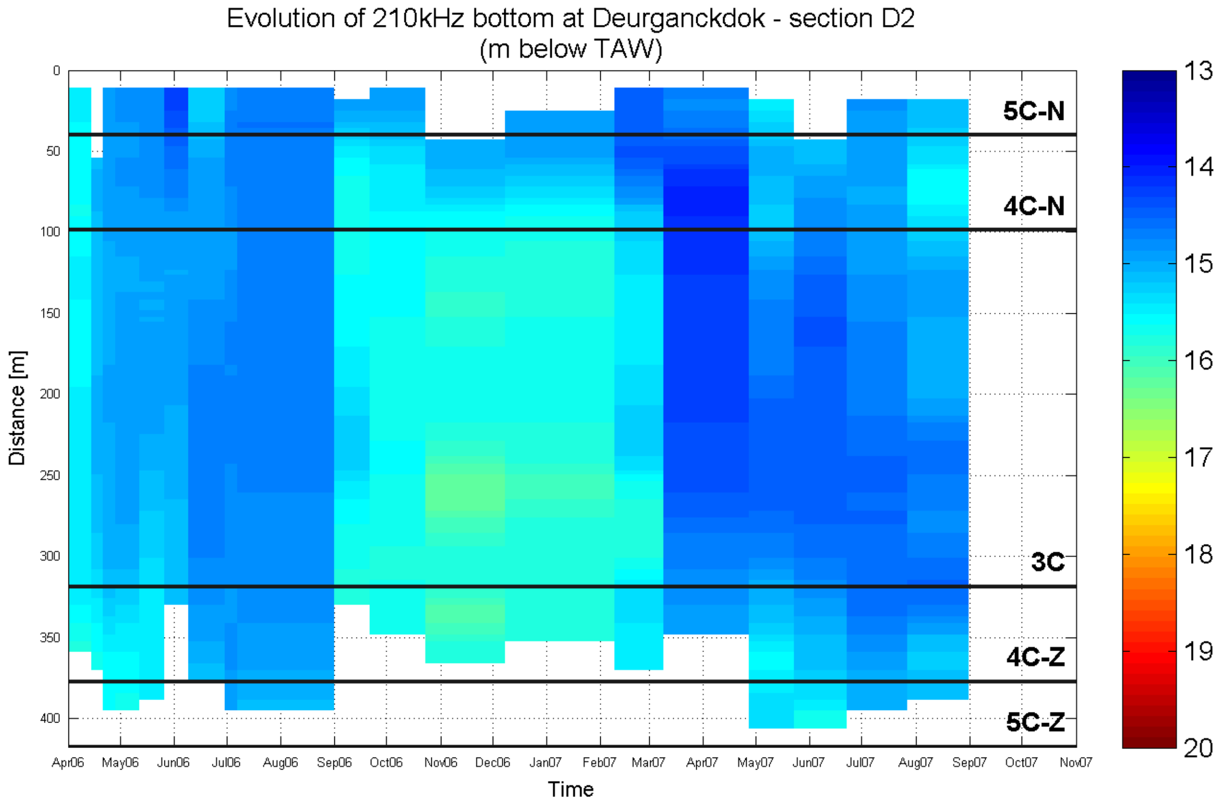
Long-term monitoring siltation Deurganckdok	
Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



	Data Processed by: IMDC In association with : I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



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In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
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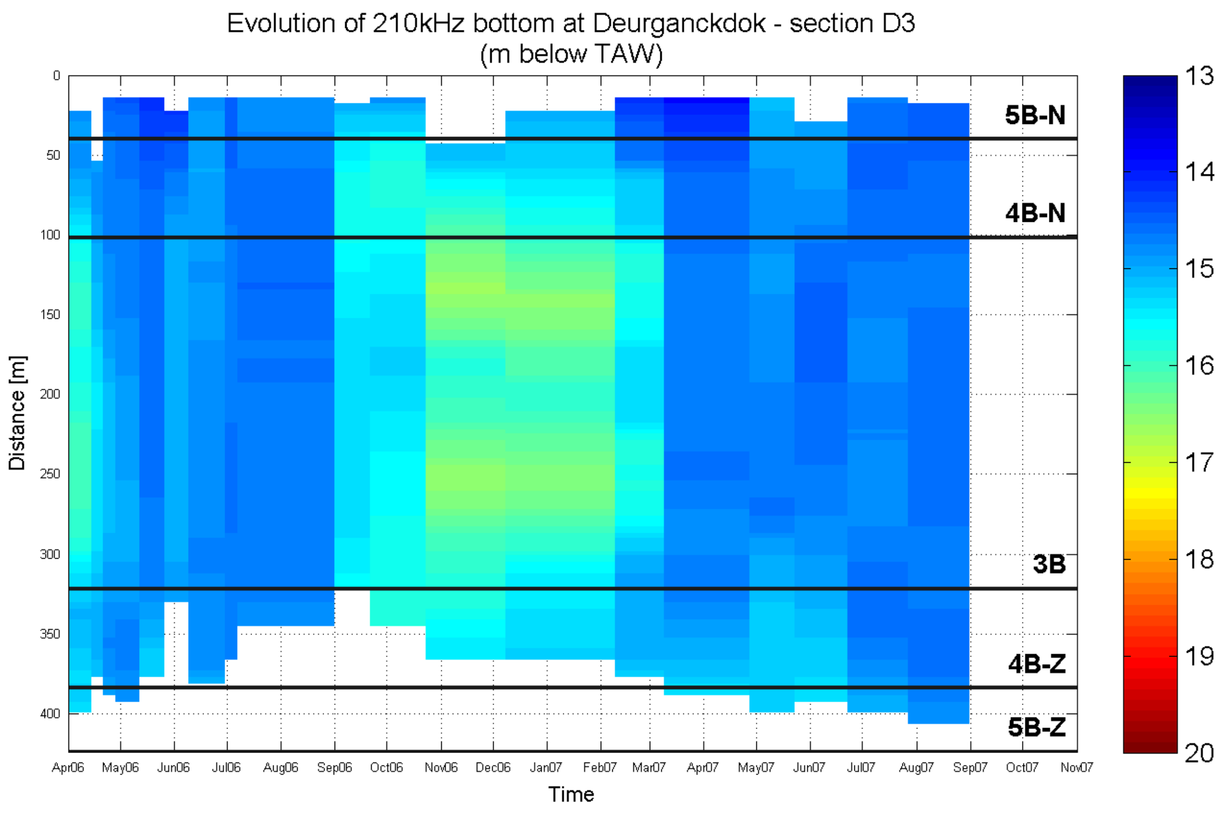

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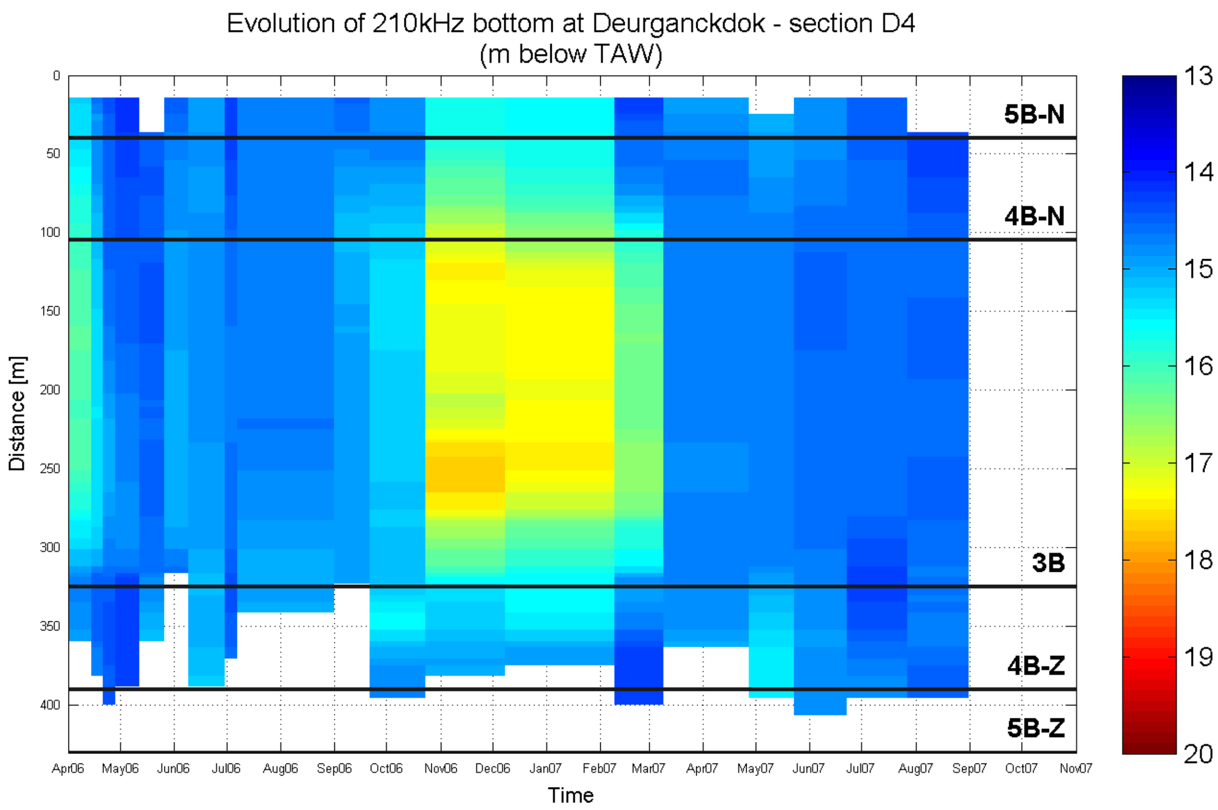
I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



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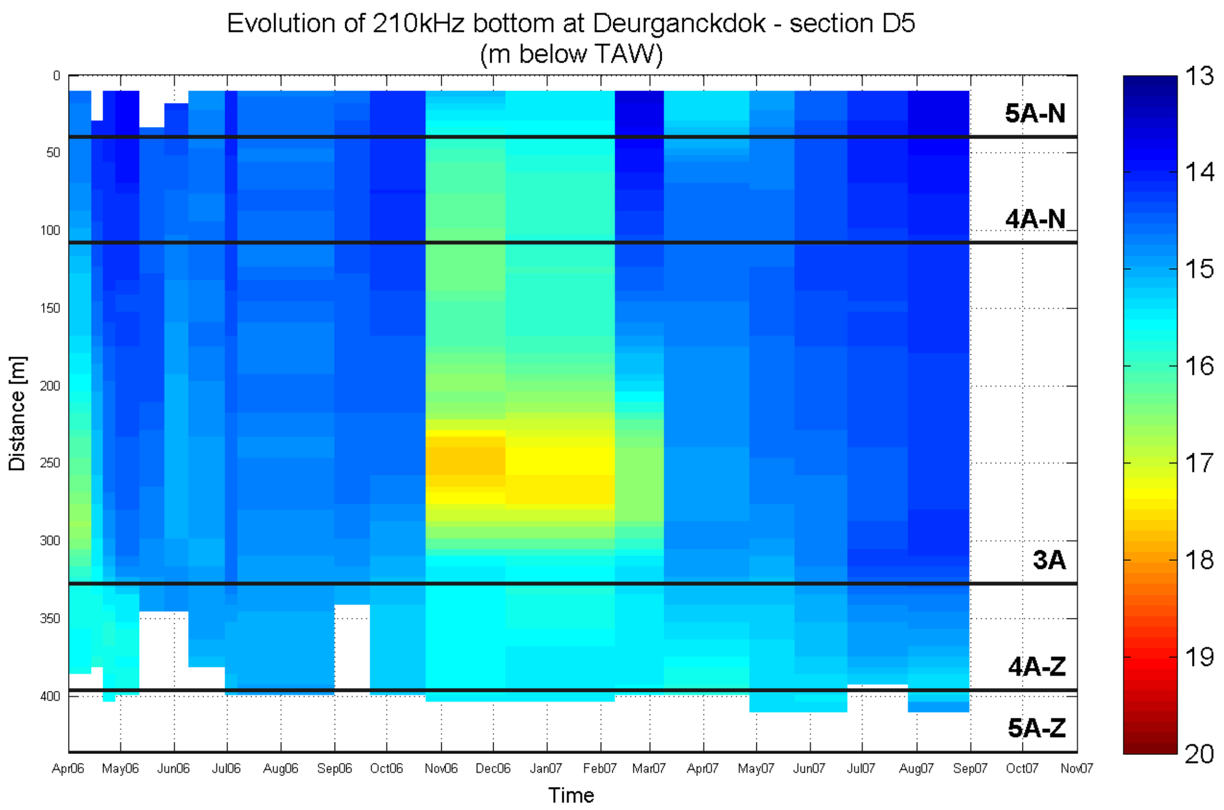
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



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In association with :

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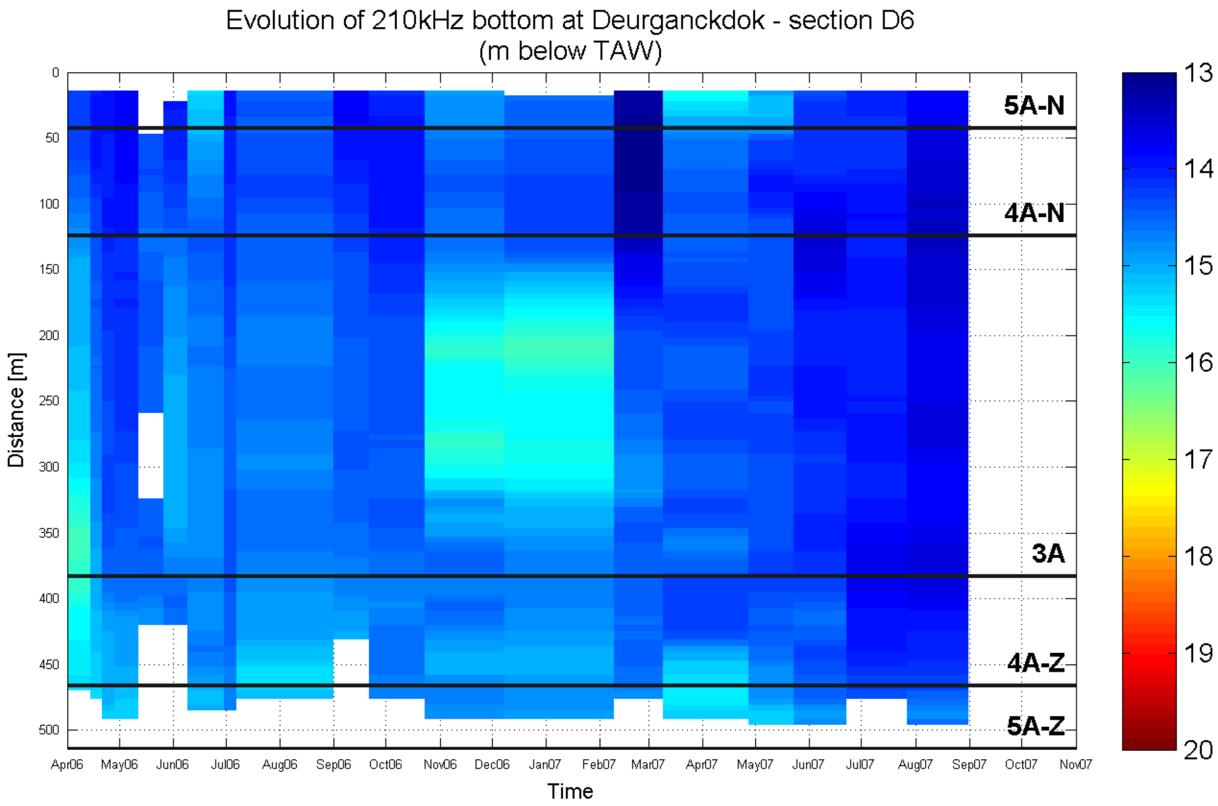
Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



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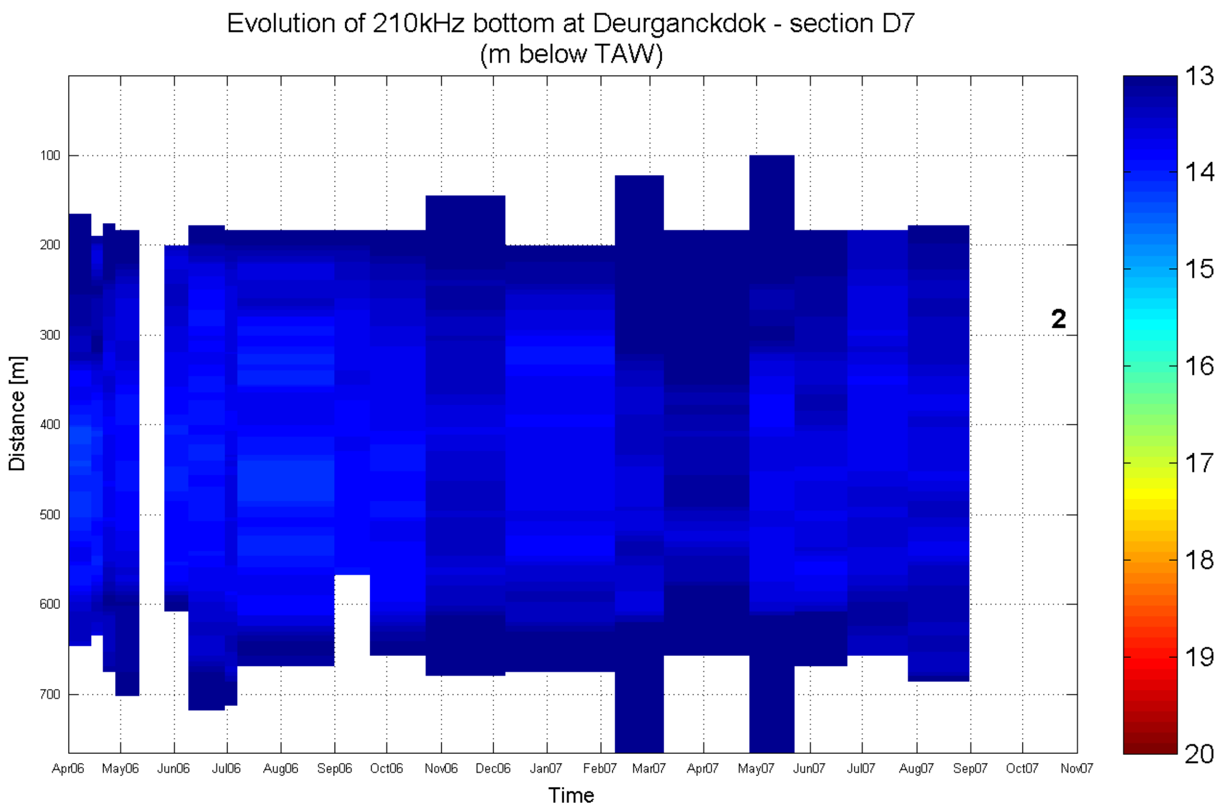
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok	
Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



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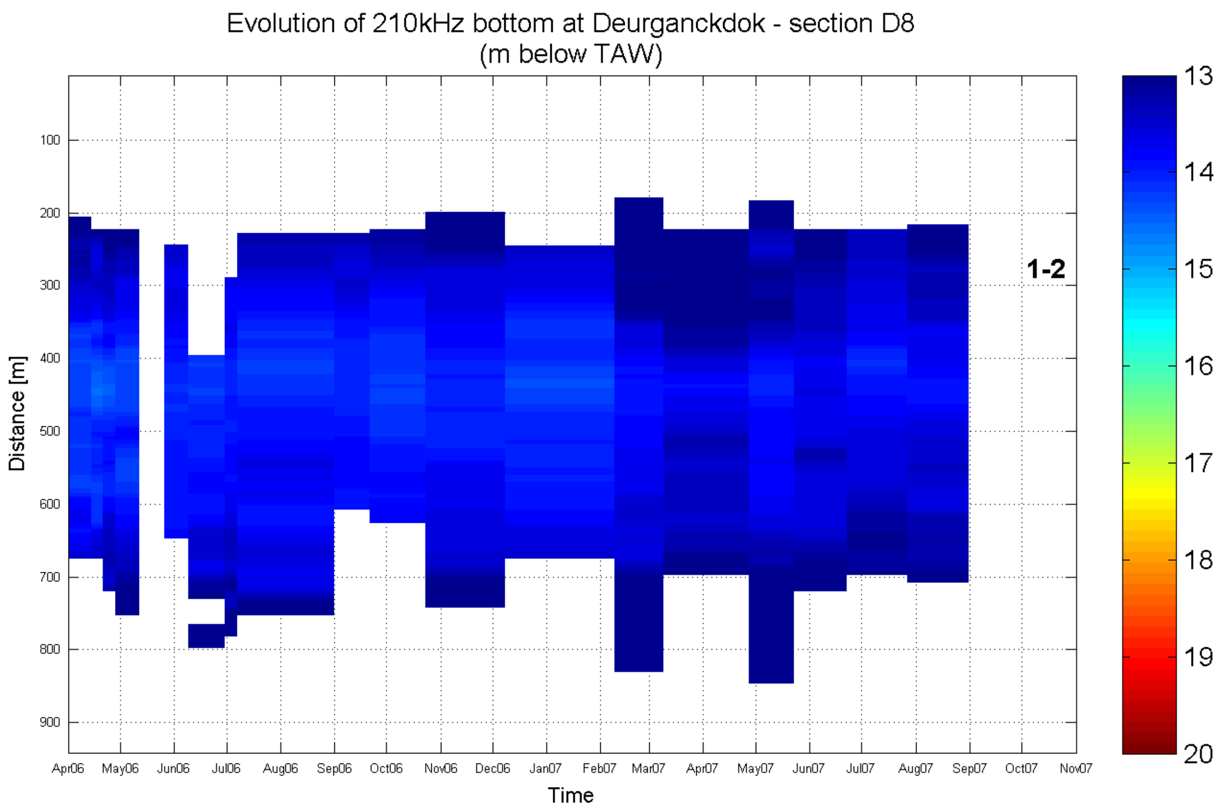
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



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In association with :

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Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
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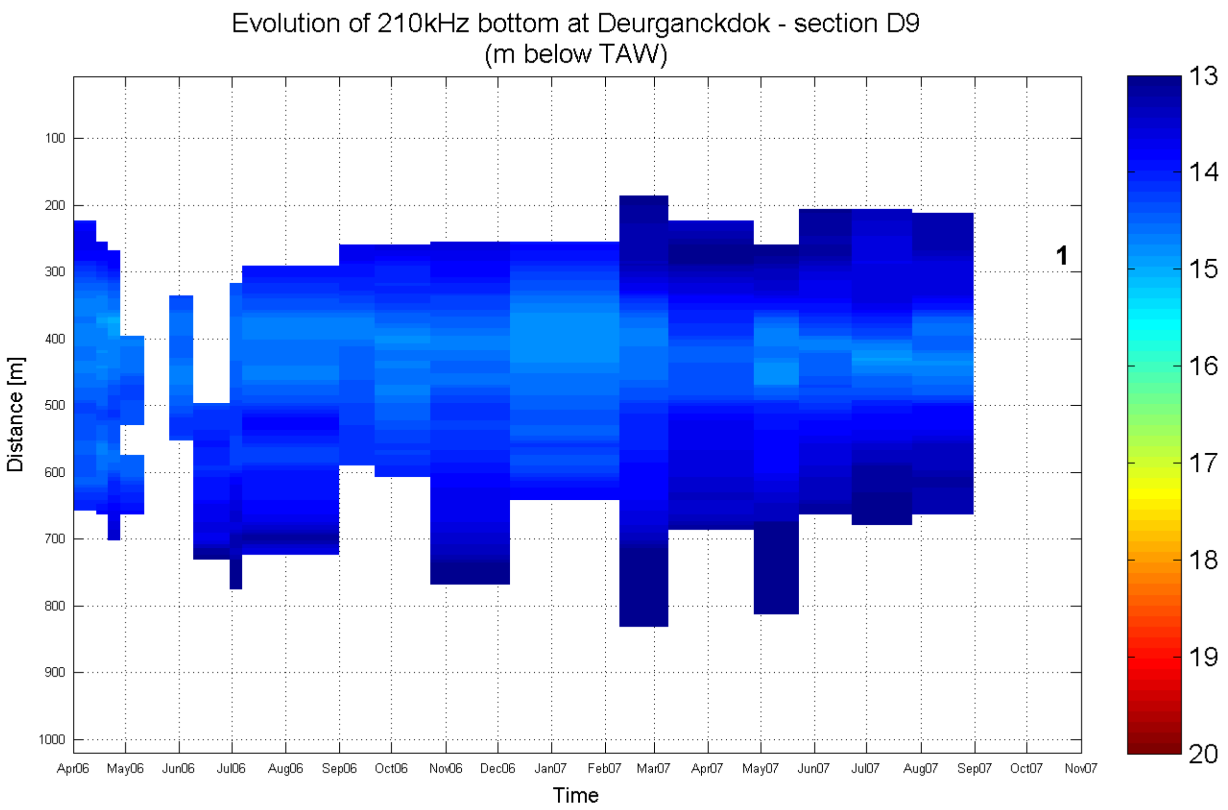

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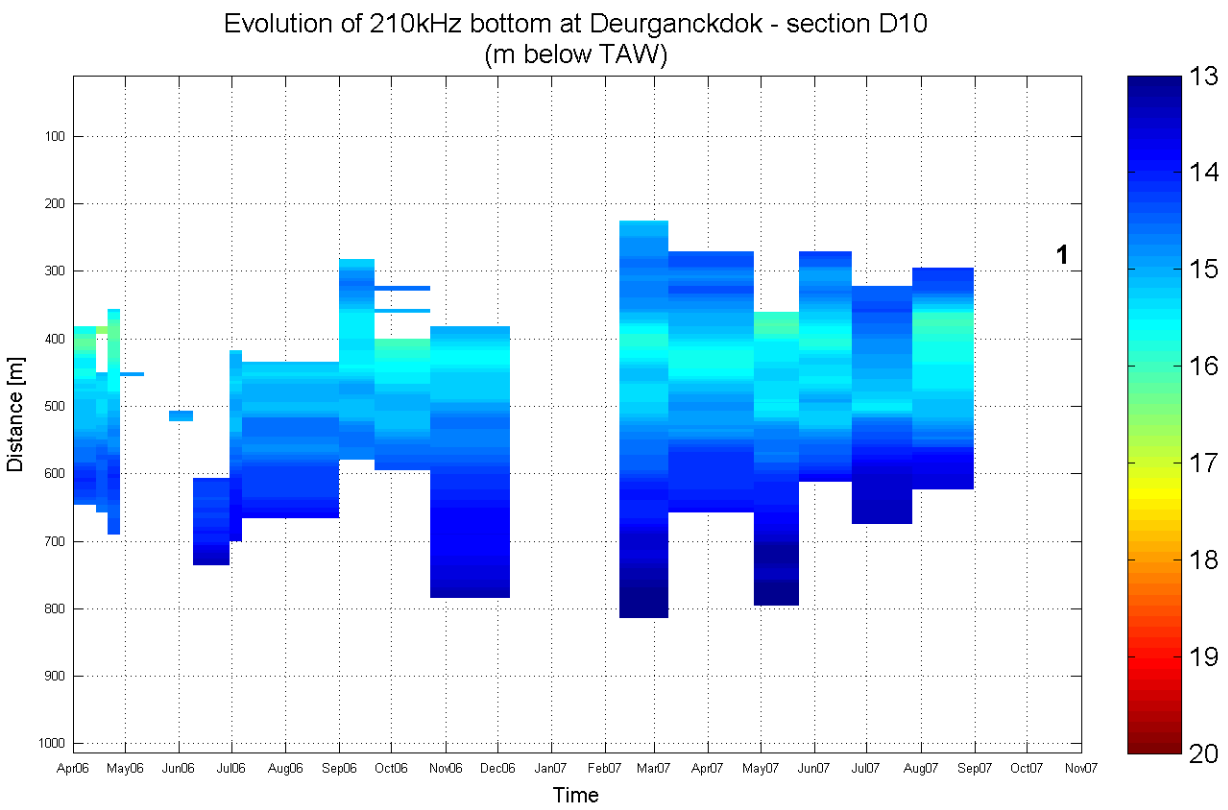
Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



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In association with :

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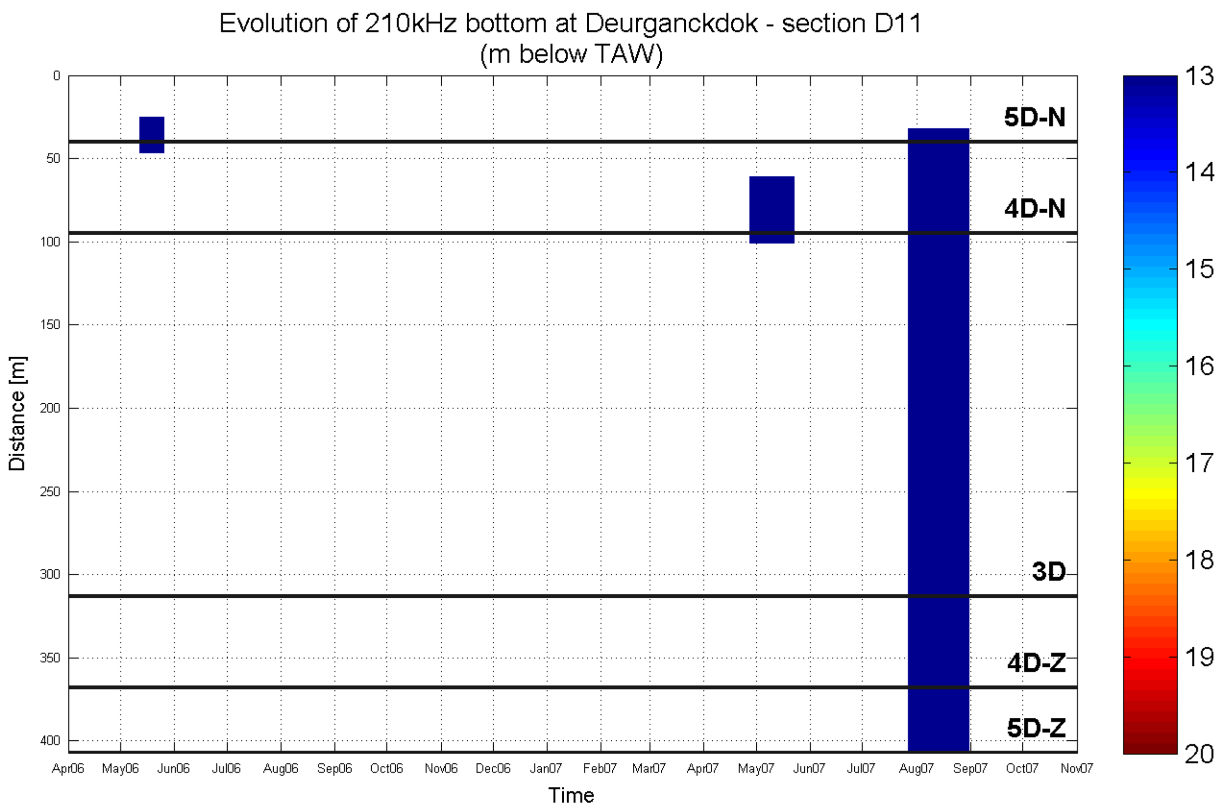
Long-term monitoring siltation Deurganckdok	
Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



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In association with :

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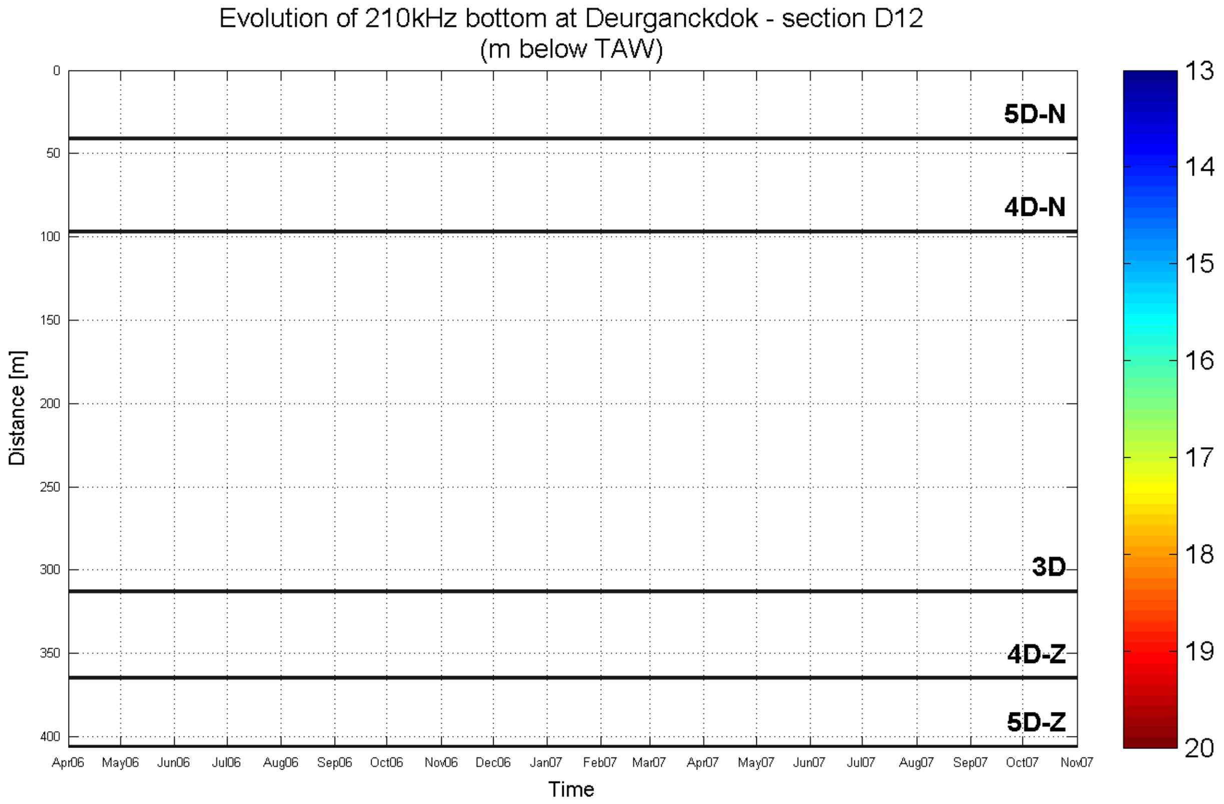
Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



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In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
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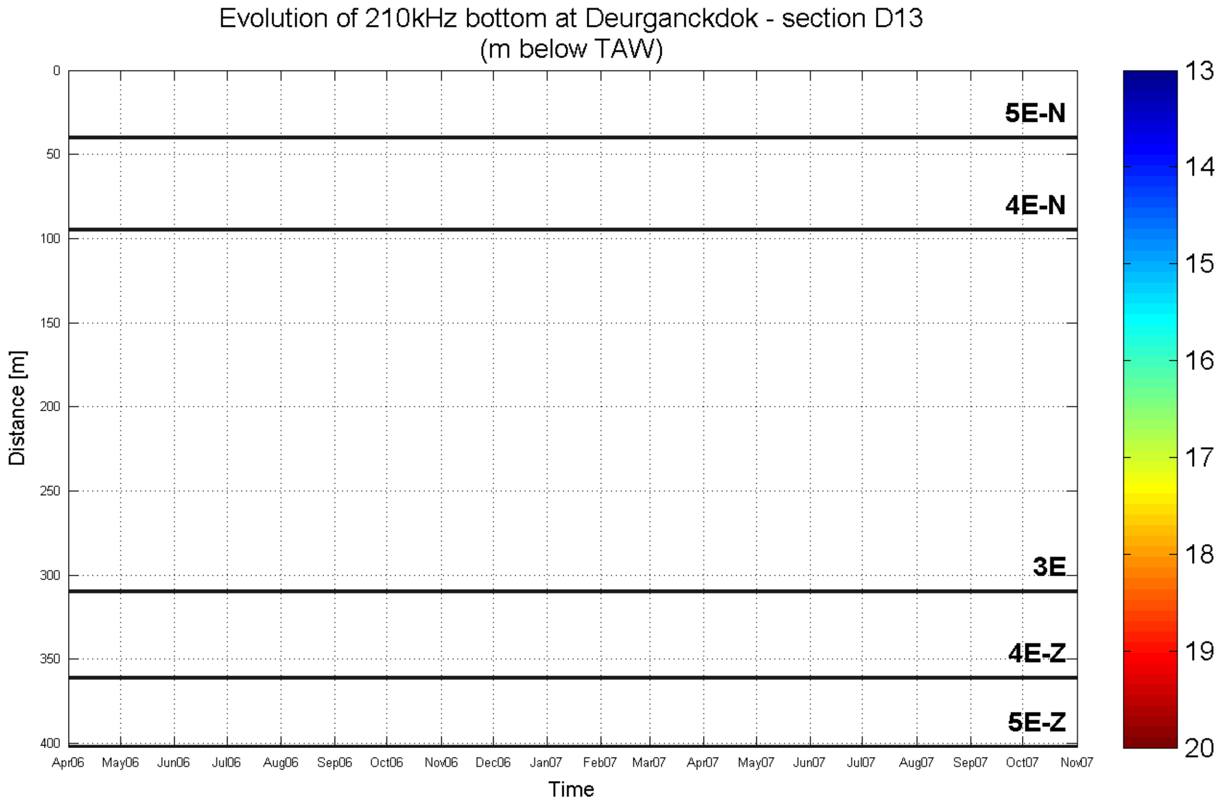

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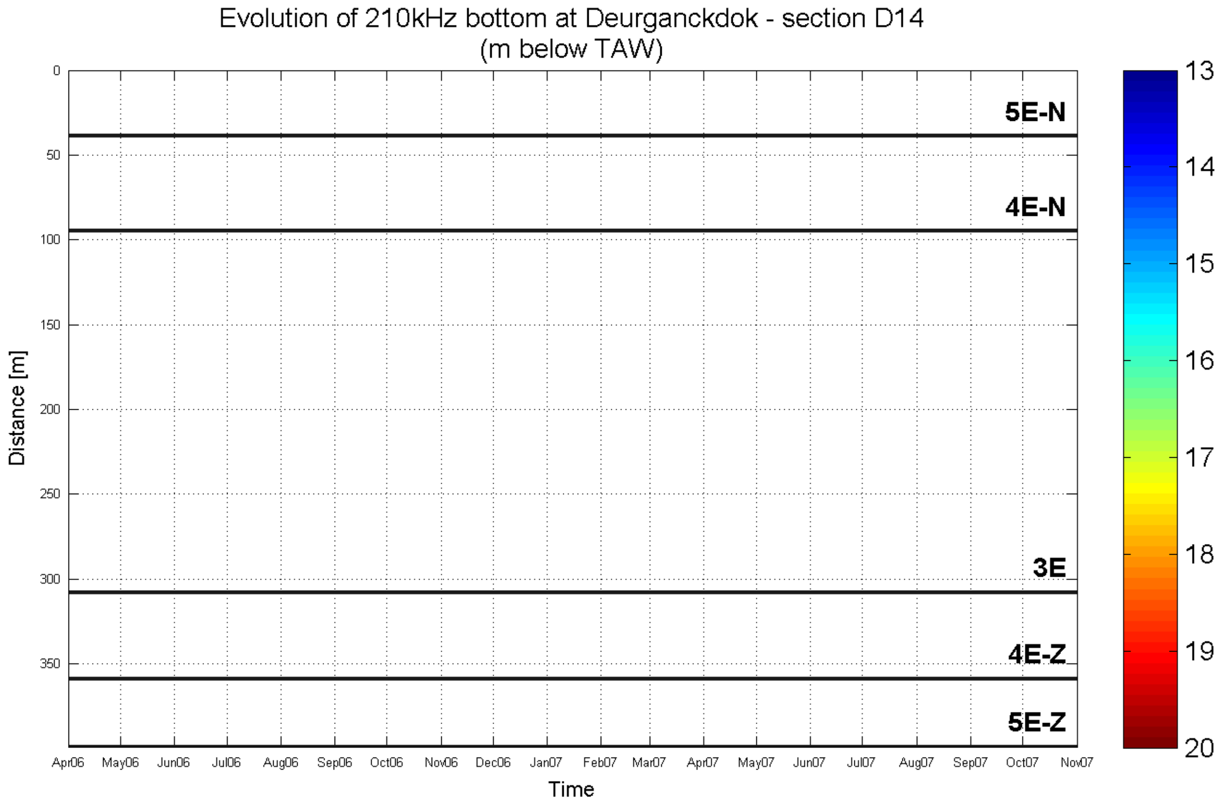
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



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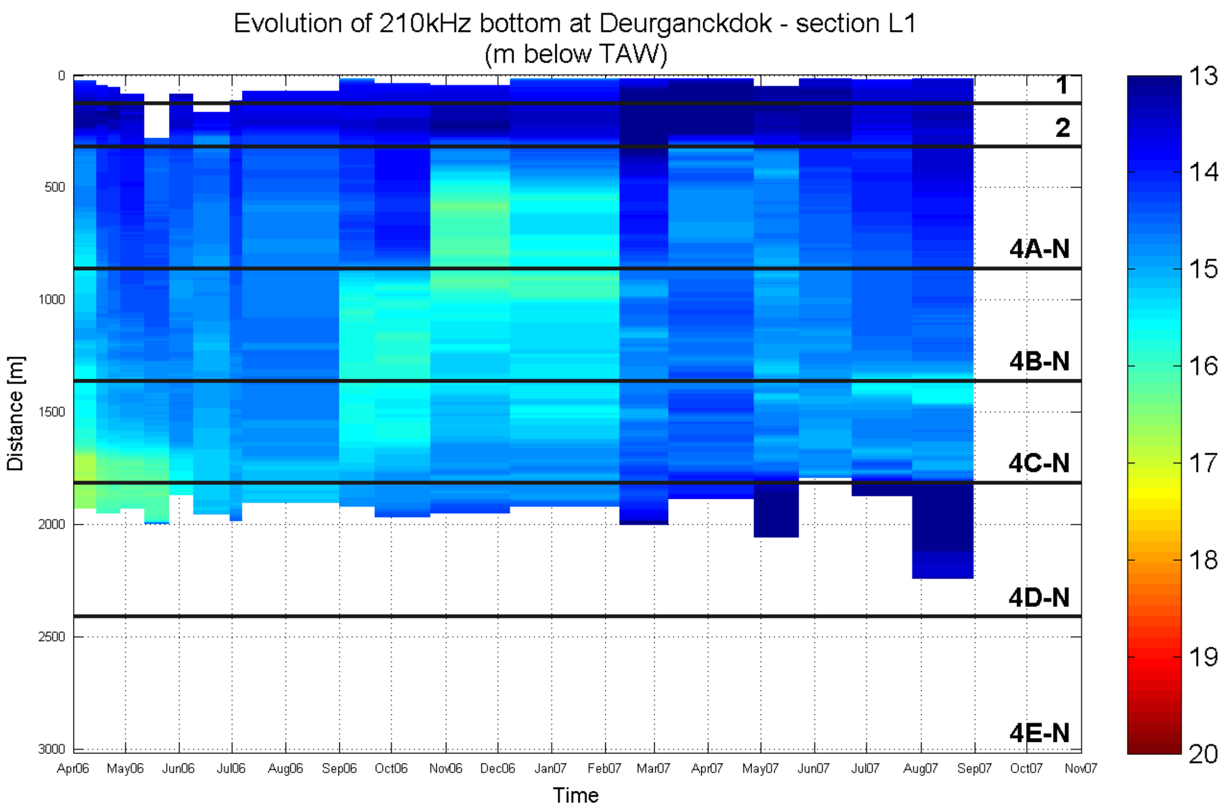
In association with :

I/RA/11283/07.081/MSA

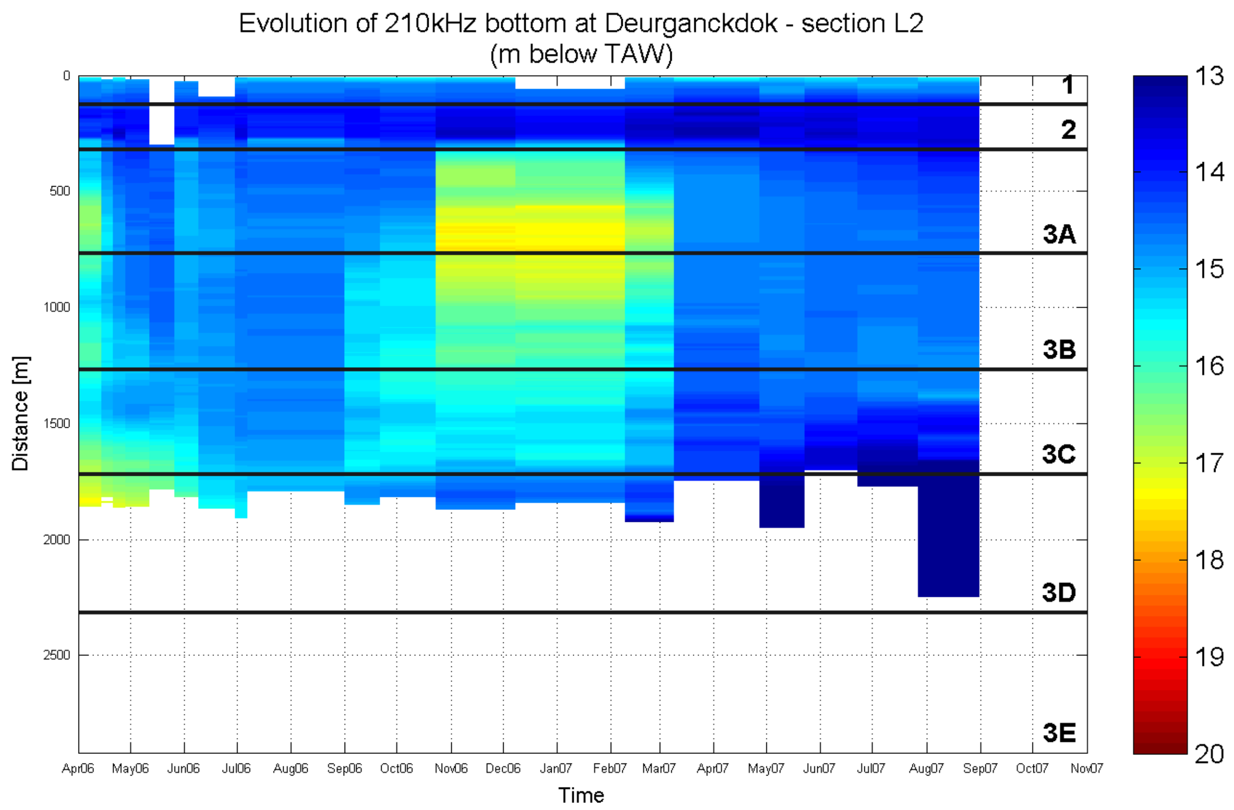
Long-term monitoring siltation Deurganckdok	
Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



	Data Processed by: IMDC In association with : I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



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In association with :

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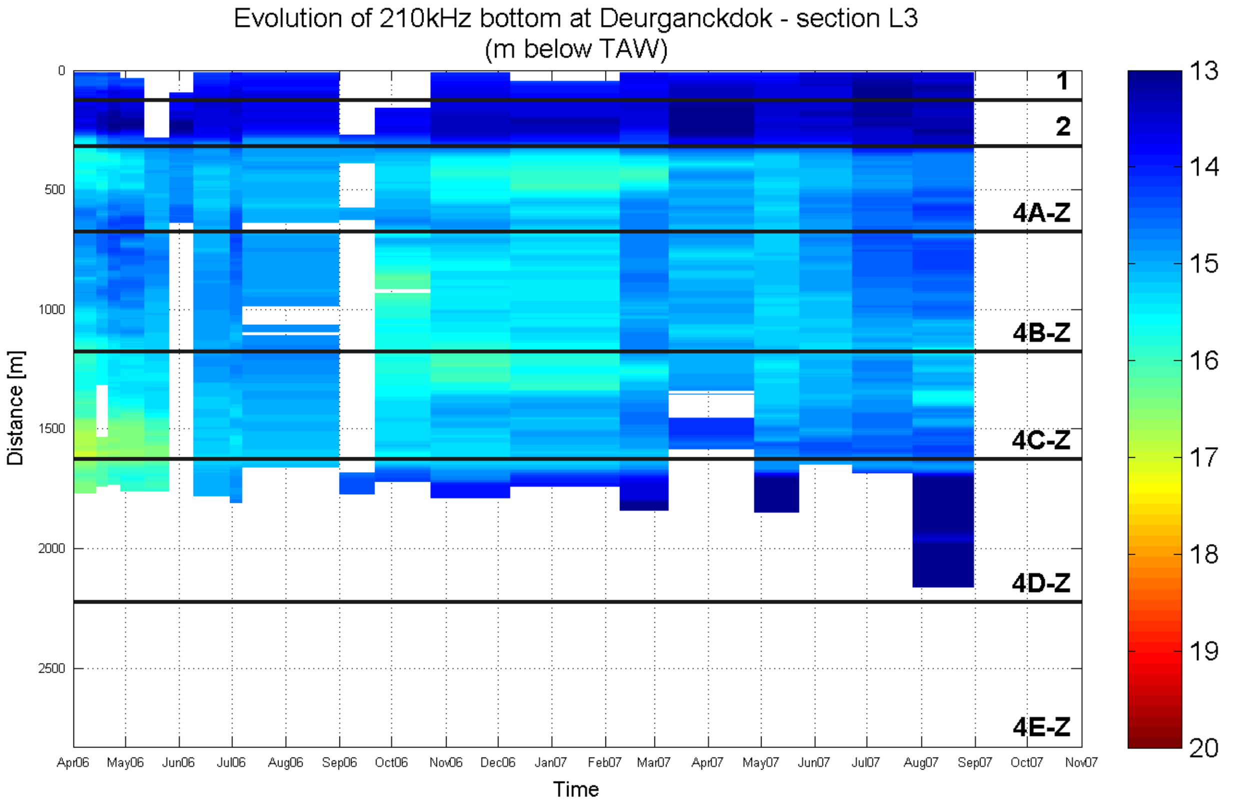
Long-term monitoring siltation Deurganckdok	
Evolution 210kHz bottom	Equipment(s): 210kHz depth sounder
	Location: DGD



Data Processed by: IMDC

In association with :

I/RA/11283/07.081/MSA

APPENDIX C.

VOLUMETRIC SILTATION RATES IN DIFFERENT ZONES AND SECTIONS

C.1 Siltation rates (tabular)

Siltation rates in cm/day

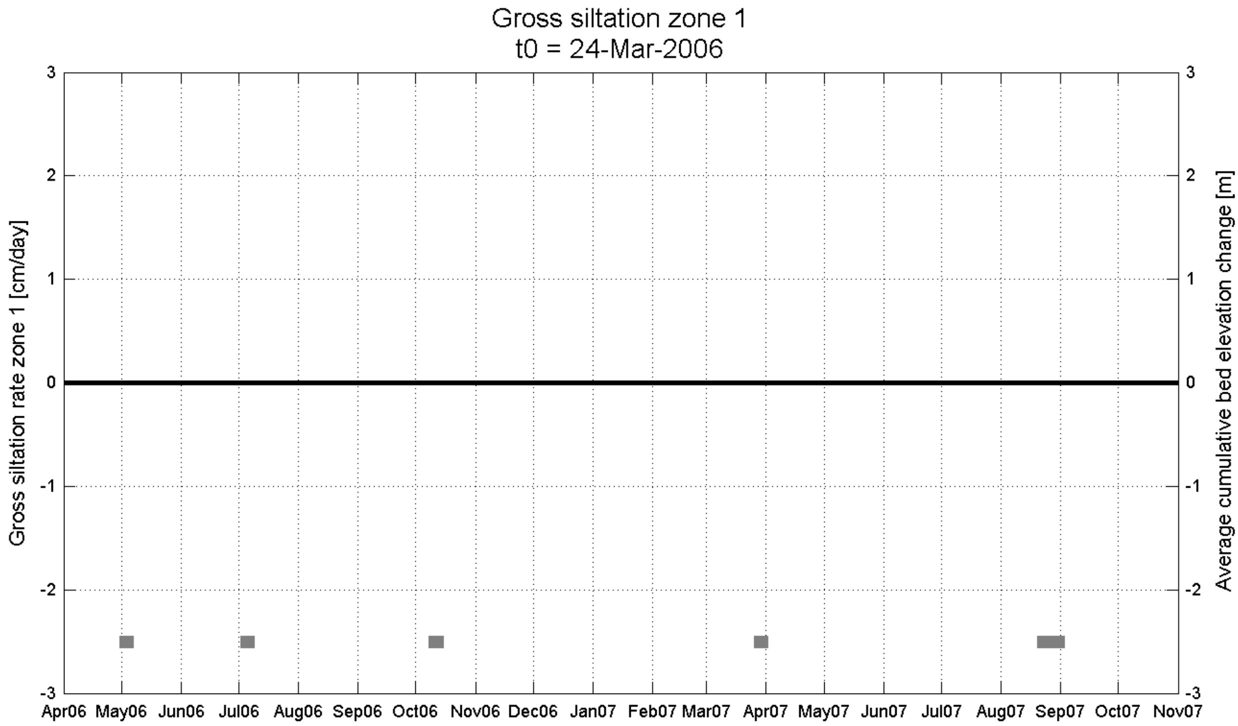
1/ Per zone		
	July 07	***August 07***
1	-	-
2	0.244	-0.198
3a	-0.066	-2.978
3b	-0.22	-2.45
3c	-0.389	-2.411
3d	-	-
3e	-	-
4Na	0.651	-0.889
4Nb	-0.042	-1.193
4Nc	-0.444	-0.536
4Nd	-	-
4Ne	-	-
4Za	0.265	0.19
4Zb	0.293	1.061
4Zc	-0.219	0.265
4Zd	-	-
4Ze	-	-
5Na	-	-
5Nb	-	-
5Nc	-0.582	1.4
5Nd	-	-
5Ne	-	-
5Za	-	-
5Zb	-	-
5Zc	-	-
5Zd	-	-
Avg	-0.046	-0.704

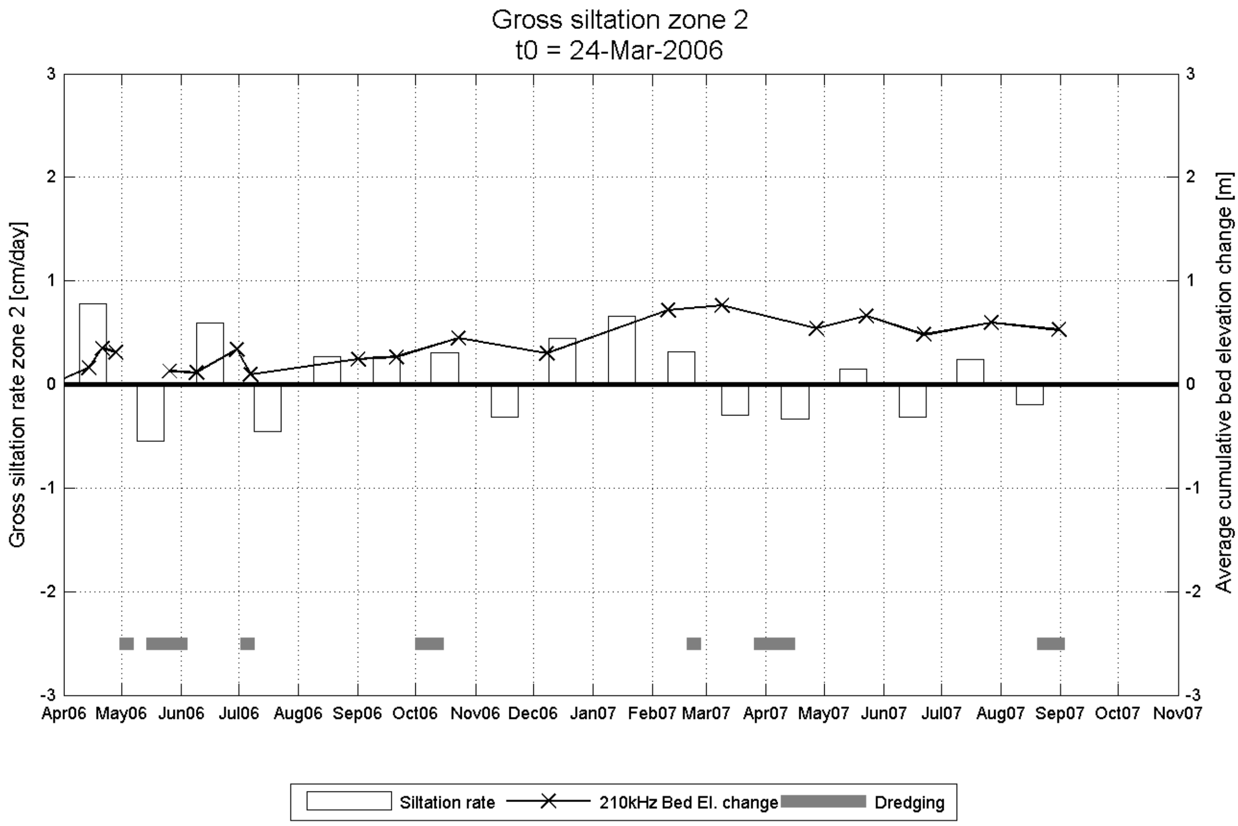
2/ Per section		
	July 07	***August 07***
D1	-0.153	-0.664
D2	-0.797	-1.381
D3	-0.029	-1.451
D4	-0.168	-1.696
D5	0.018	-2.01
D6	0.51	-0.816
D7	0.193	-0.112
D8	-0.122	-0.352
D9	-0.046	-0.046
D10	-	-
D11	-	-
D12	-	-
D13	-	-
D14	-	-
L1	0.4	-0.772
L2	0.127	-2.116
L3	0.279	0.415

C.2 Water-bed interface evolution for all zones

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





Reference level: depth sounding 24-Mar-2006

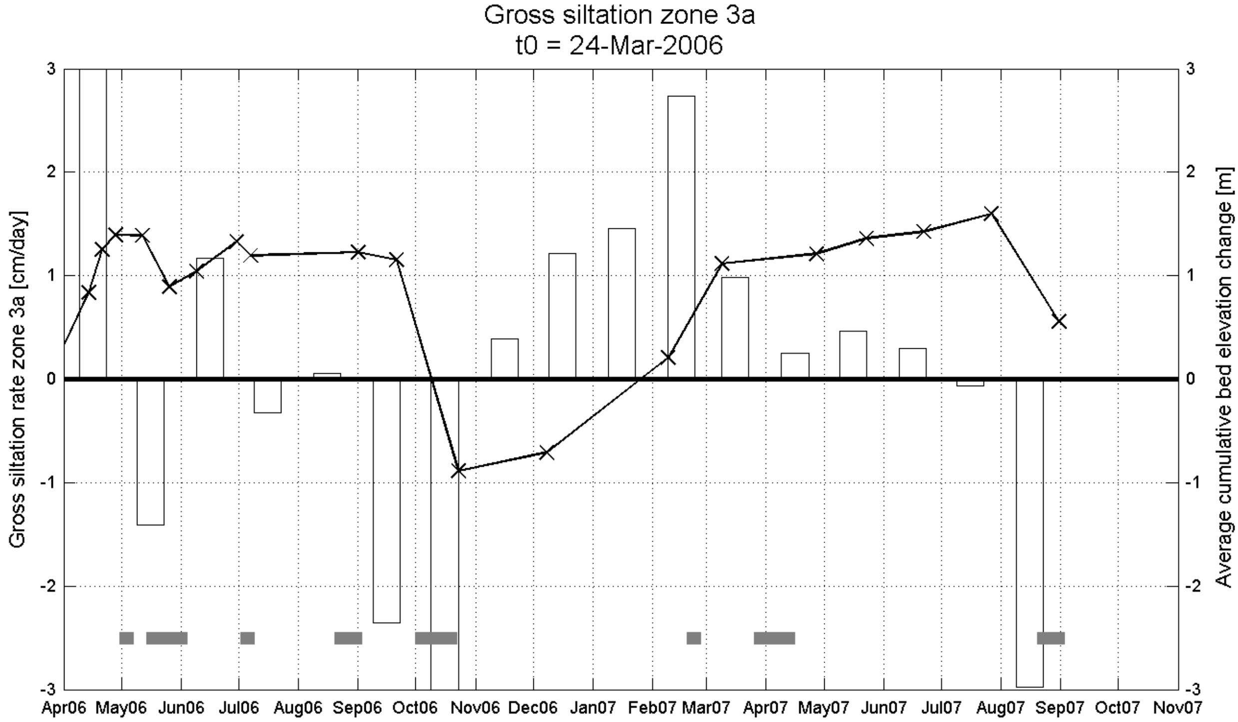
Data Processed by:

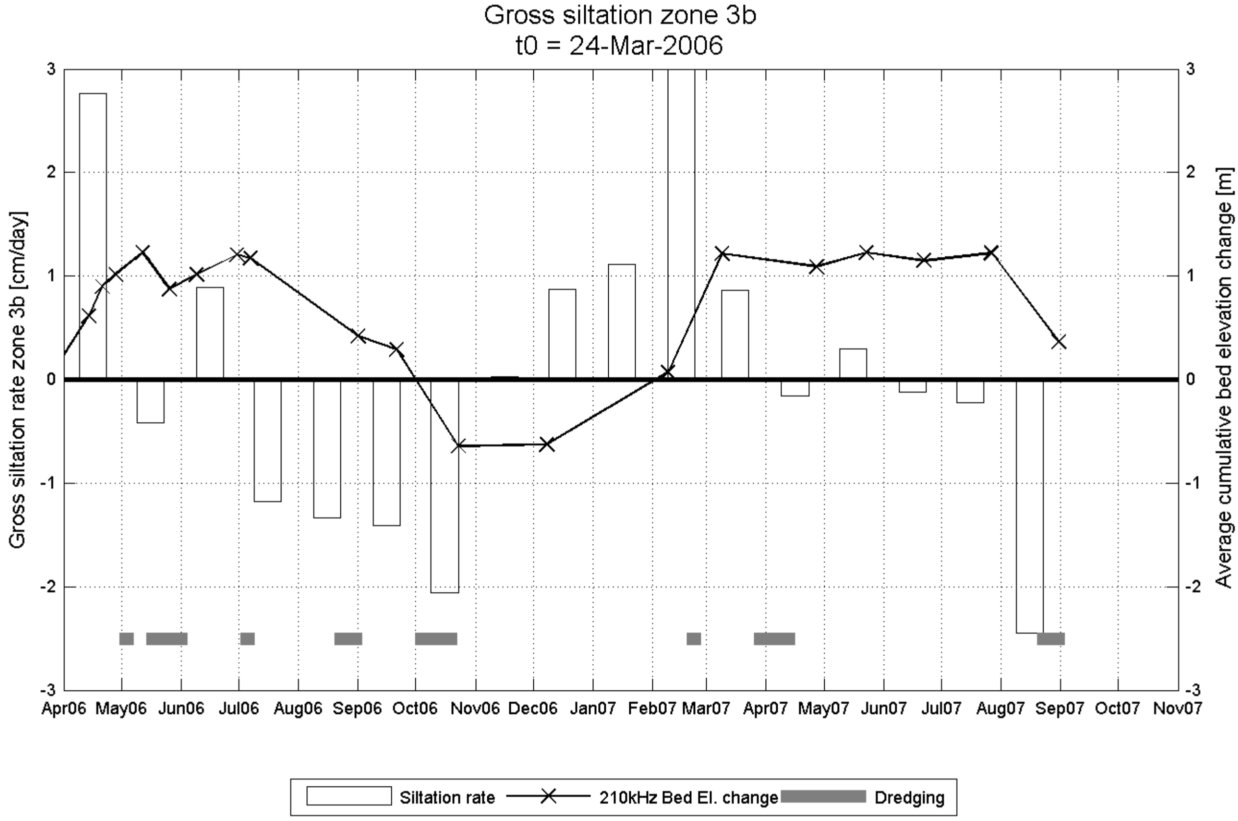
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





Reference level: depth sounding 24-Mar-2006

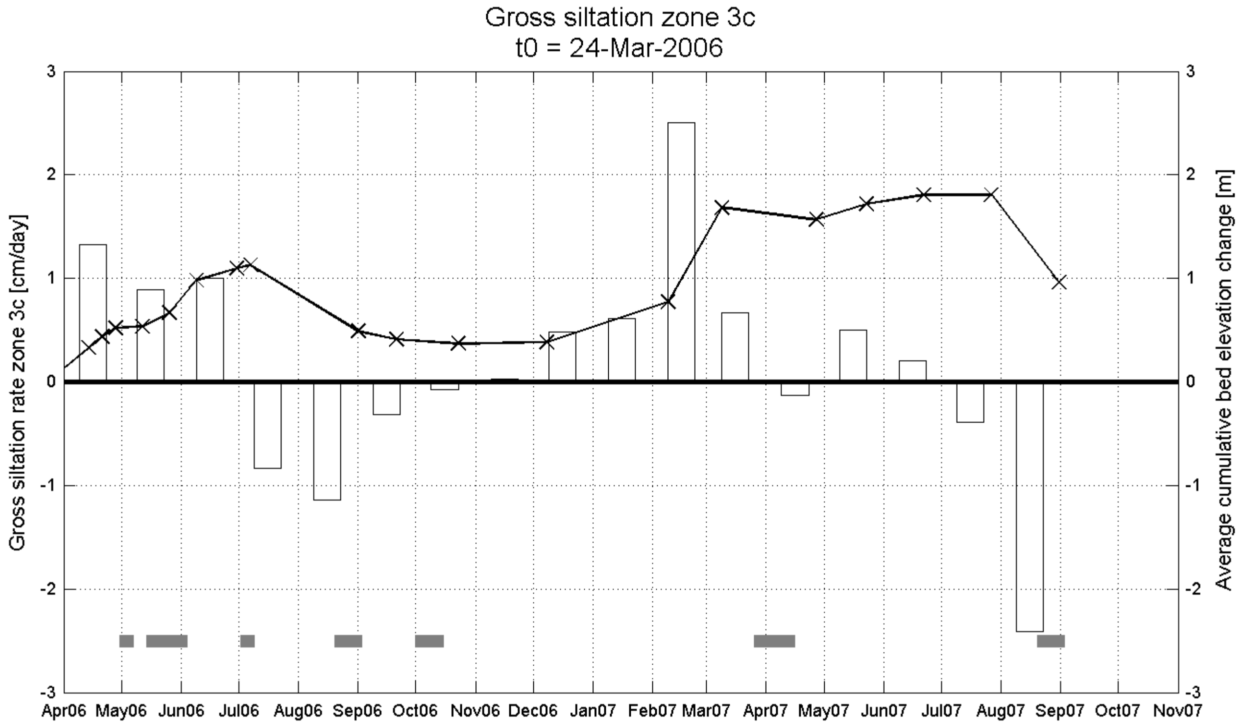
Data Processed by: IMDC

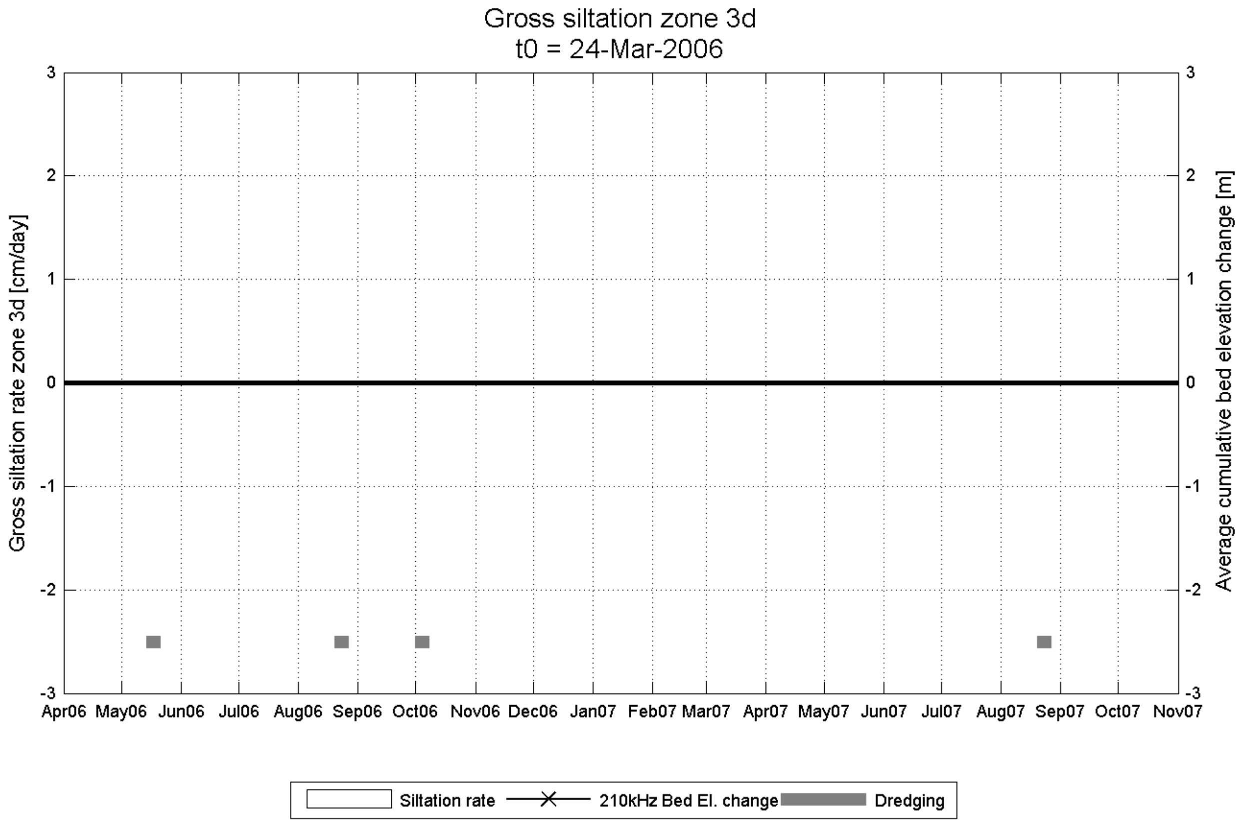
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





Reference level: depth sounding 24-Mar-2006

Data Processed by: IMDC

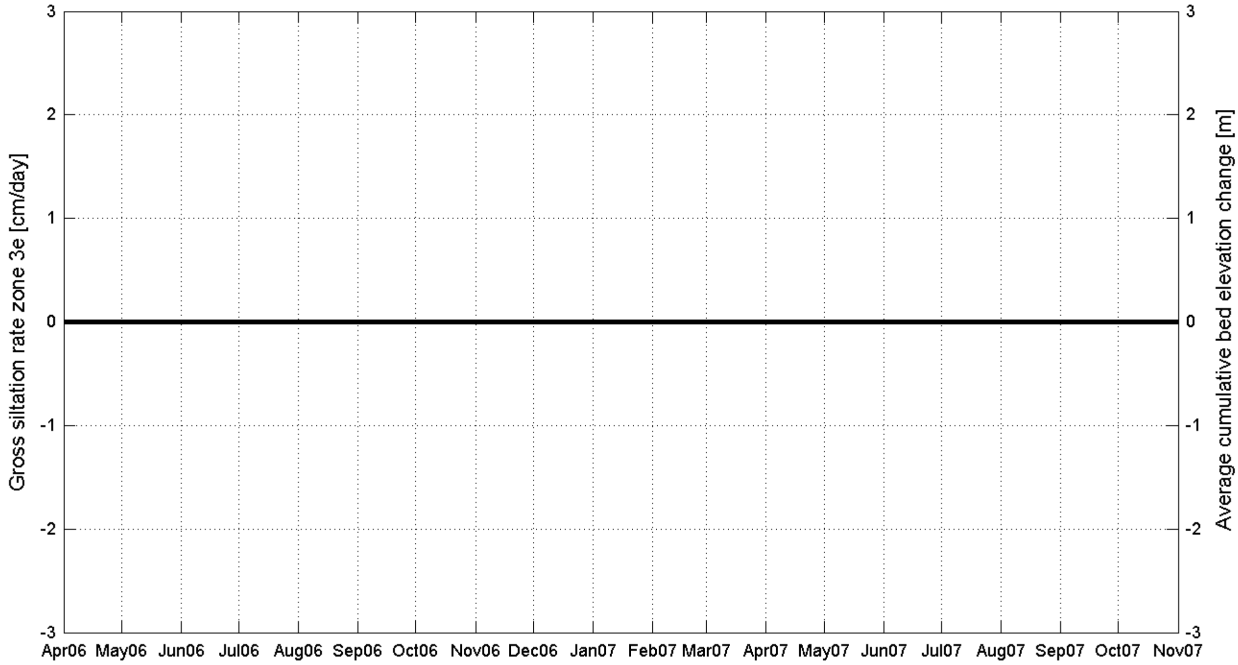
In association with :

I/RA/11283/07.081/MSA

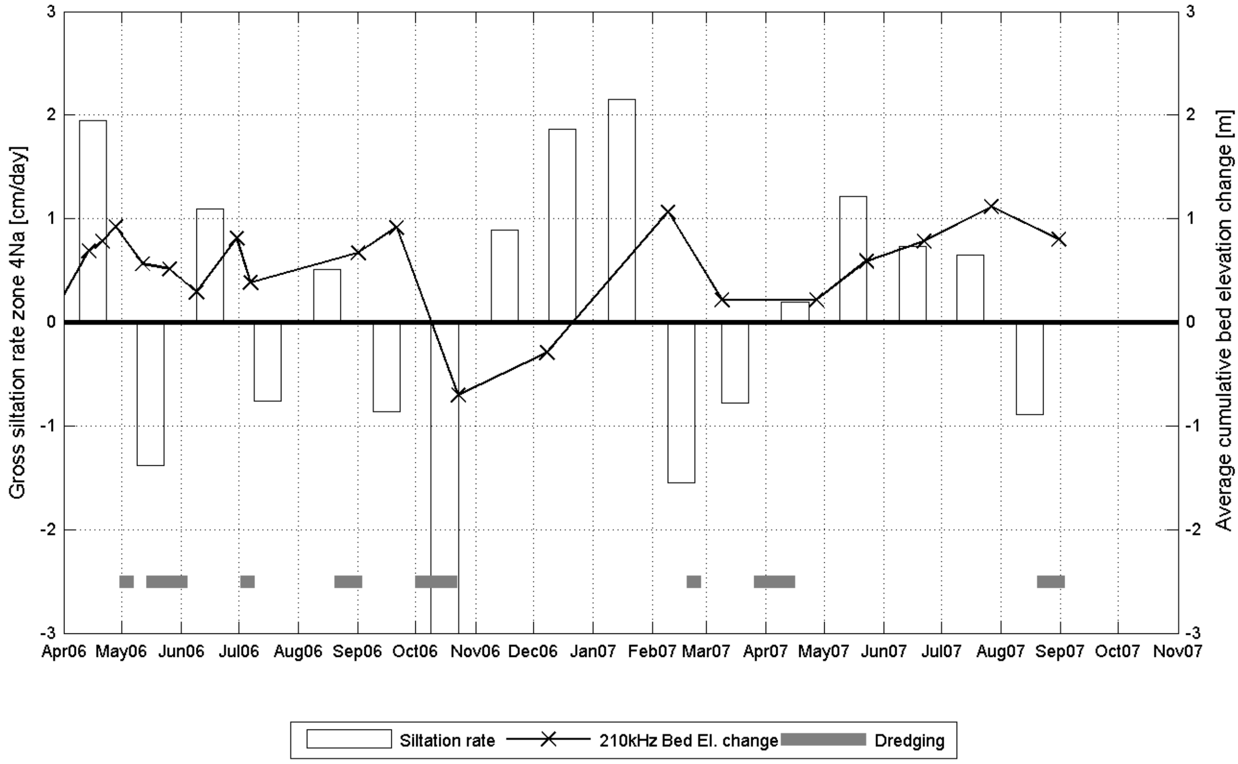
Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD

Gross siltation zone 3e
t0 = 24-Mar-2006



Gross siltation zone 4Na
t0 = 24-Mar-2006



Reference level: depth sounding 24-Mar-2006

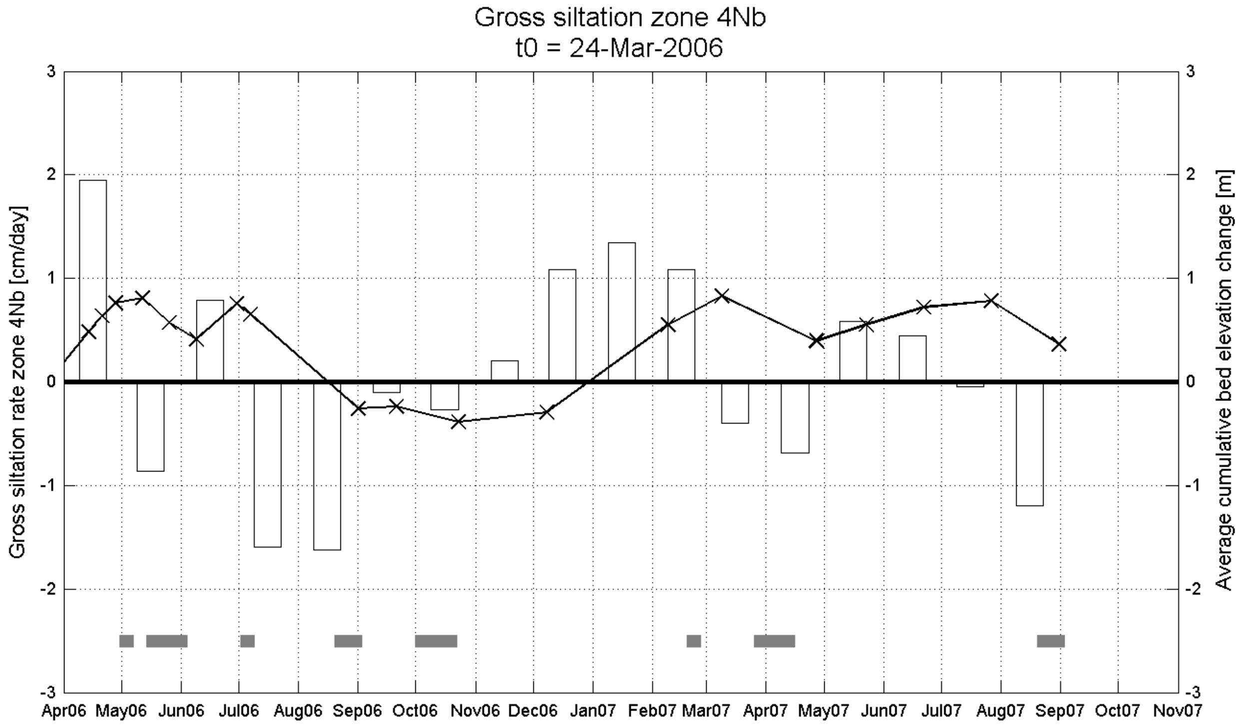
Data Processed by: IMDC

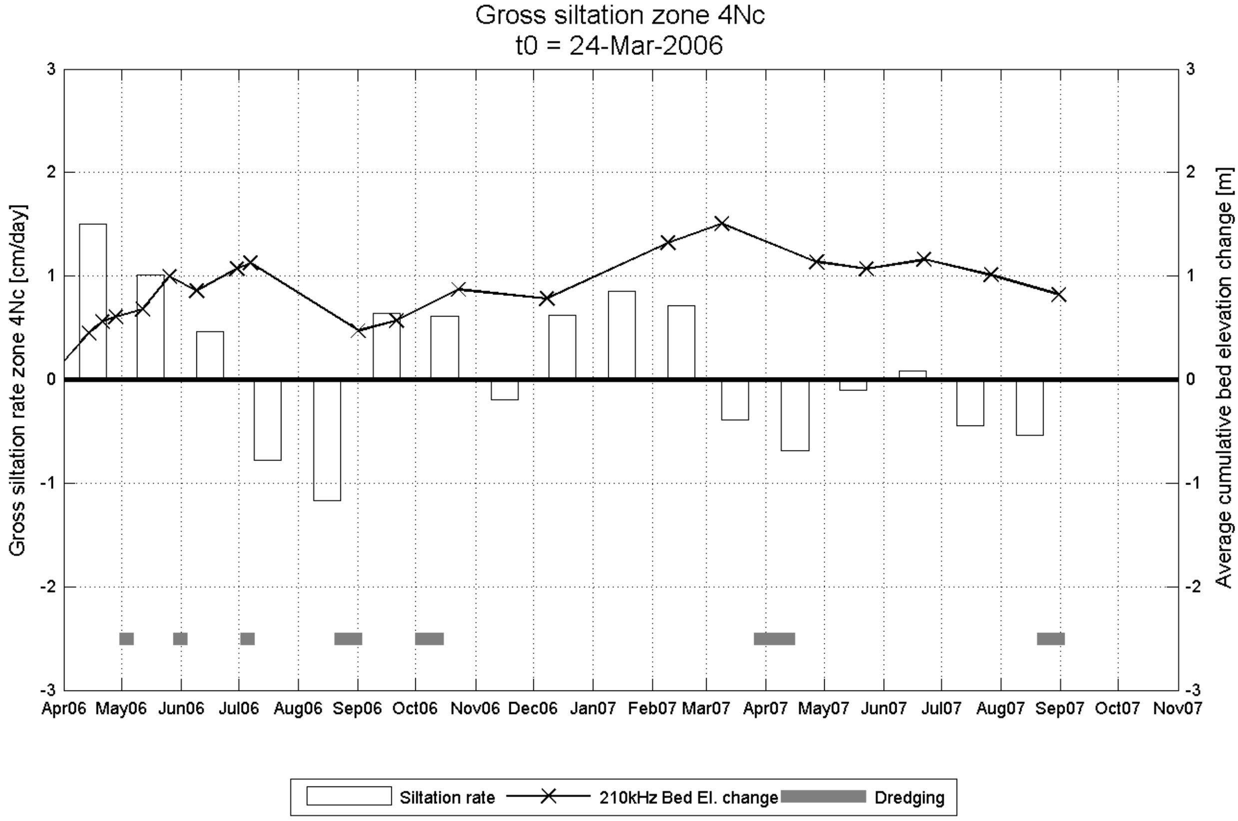
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





Reference level: depth sounding 24-Mar-2006

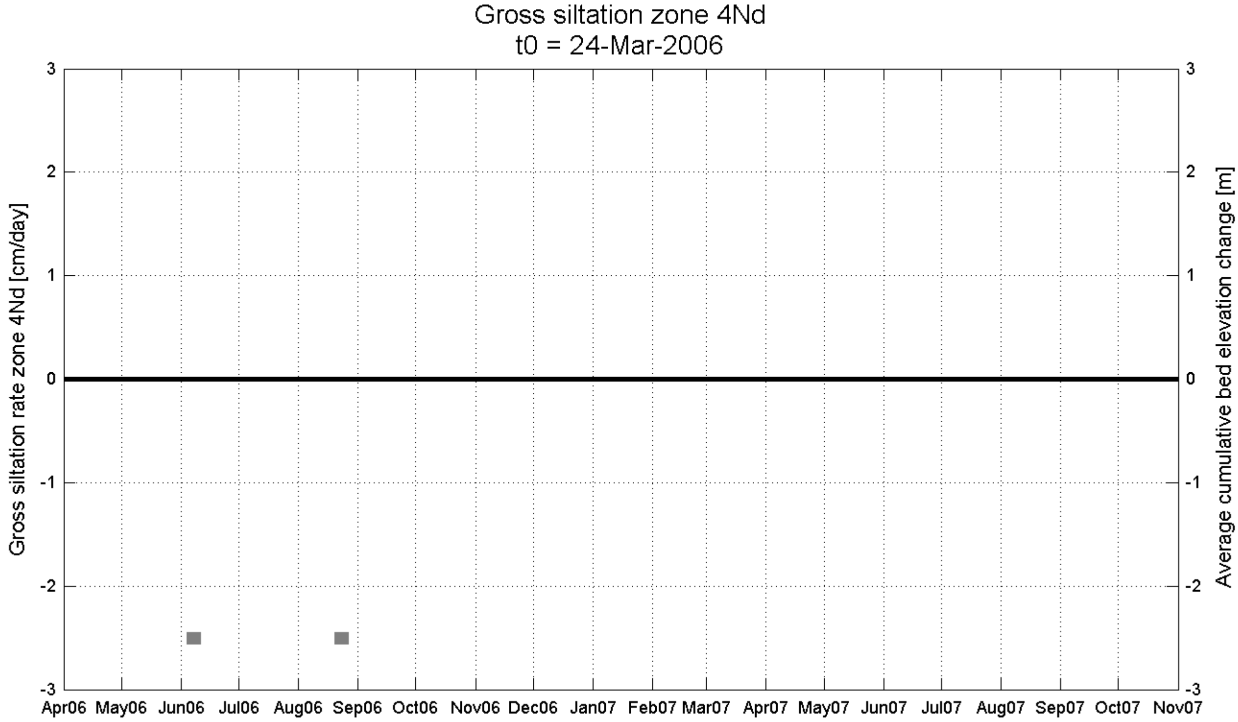
Data Processed by:

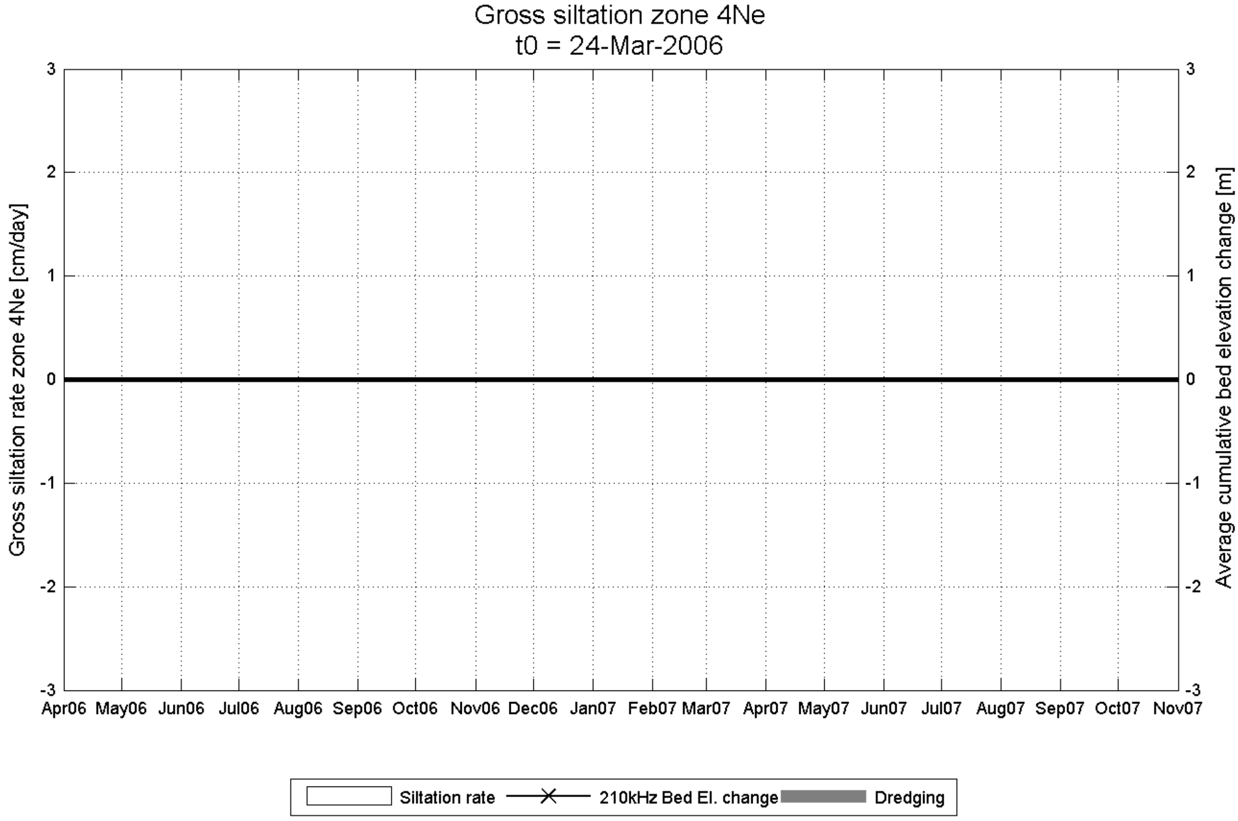
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





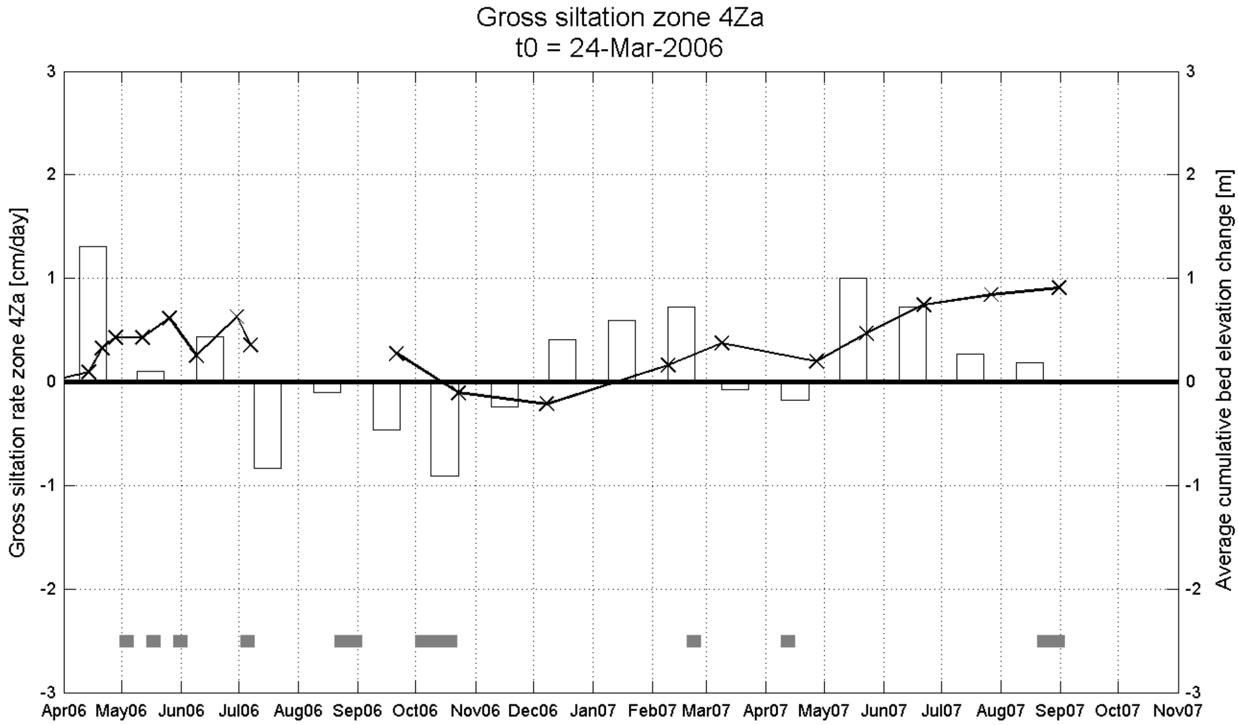
Reference level: depth sounding 24-Mar-2006

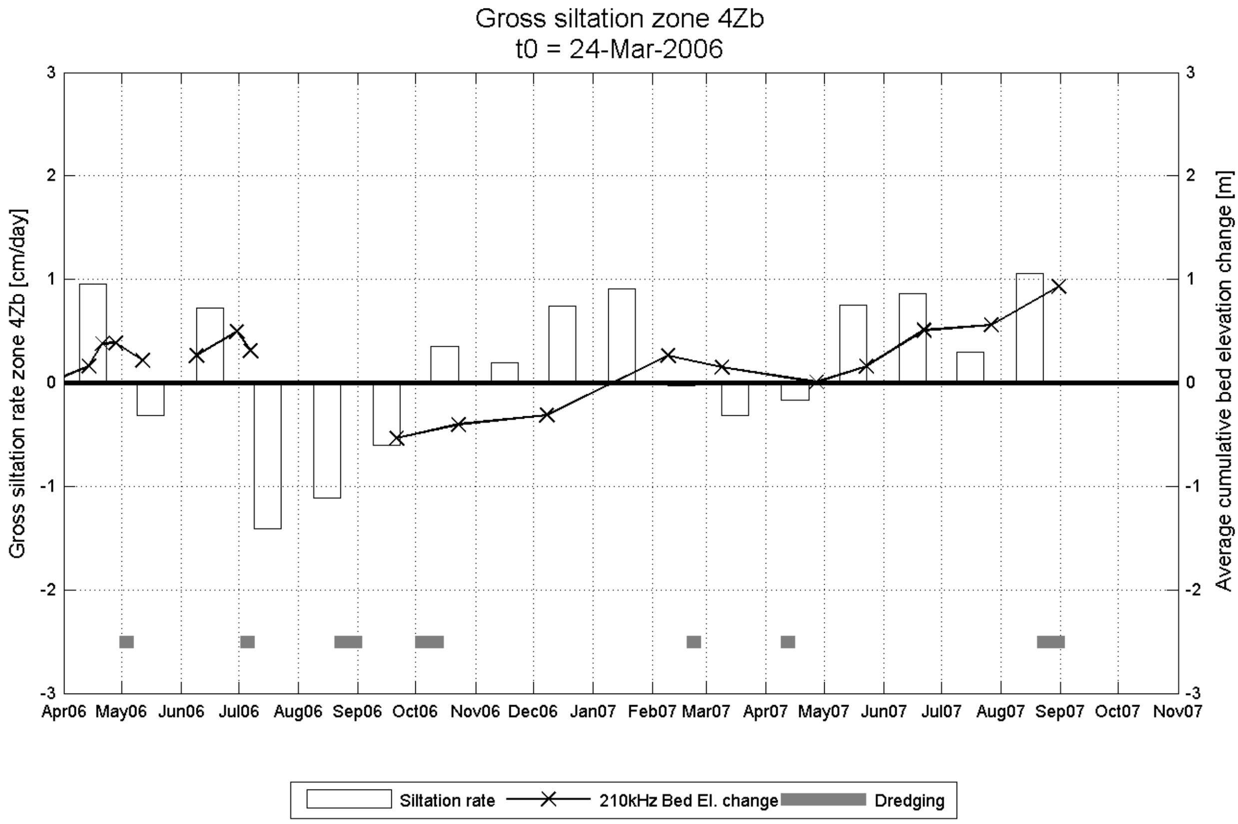
Data Processed by: IMDC

In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok	
Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





Reference level: depth sounding 24-Mar-2006	Data Processed by: IMDC In association with : I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

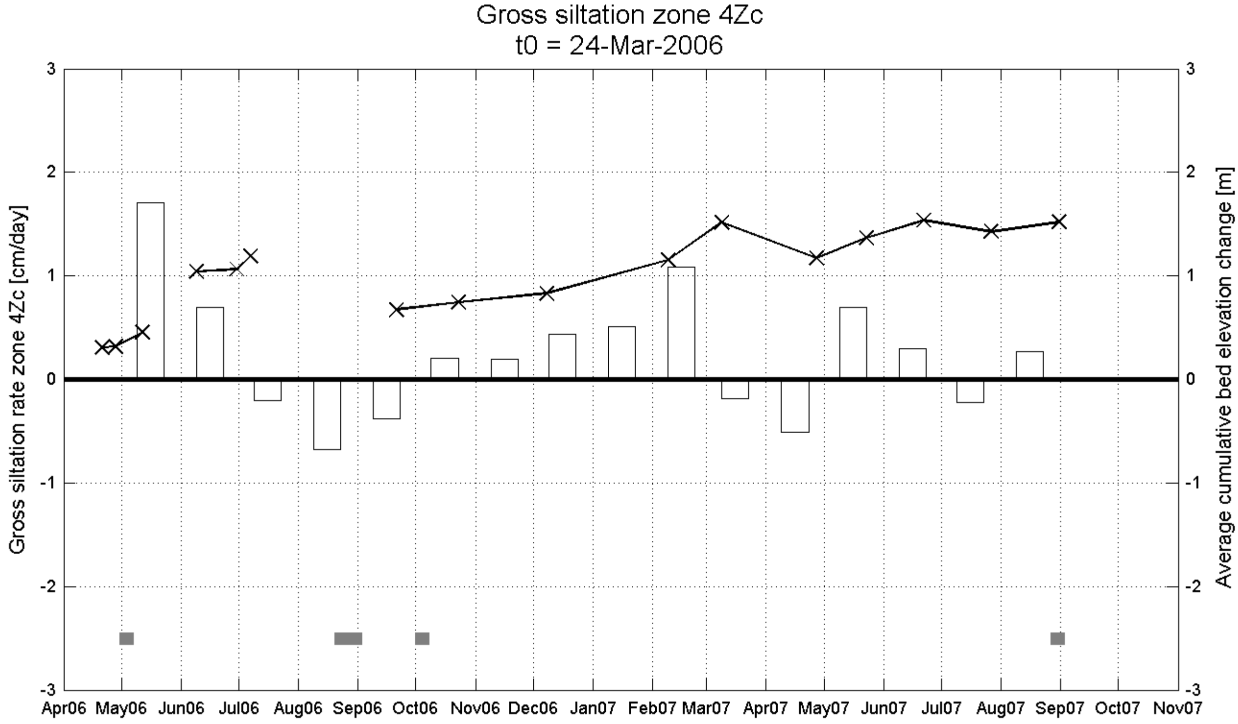
Siltation height / monthly gross siltation rate

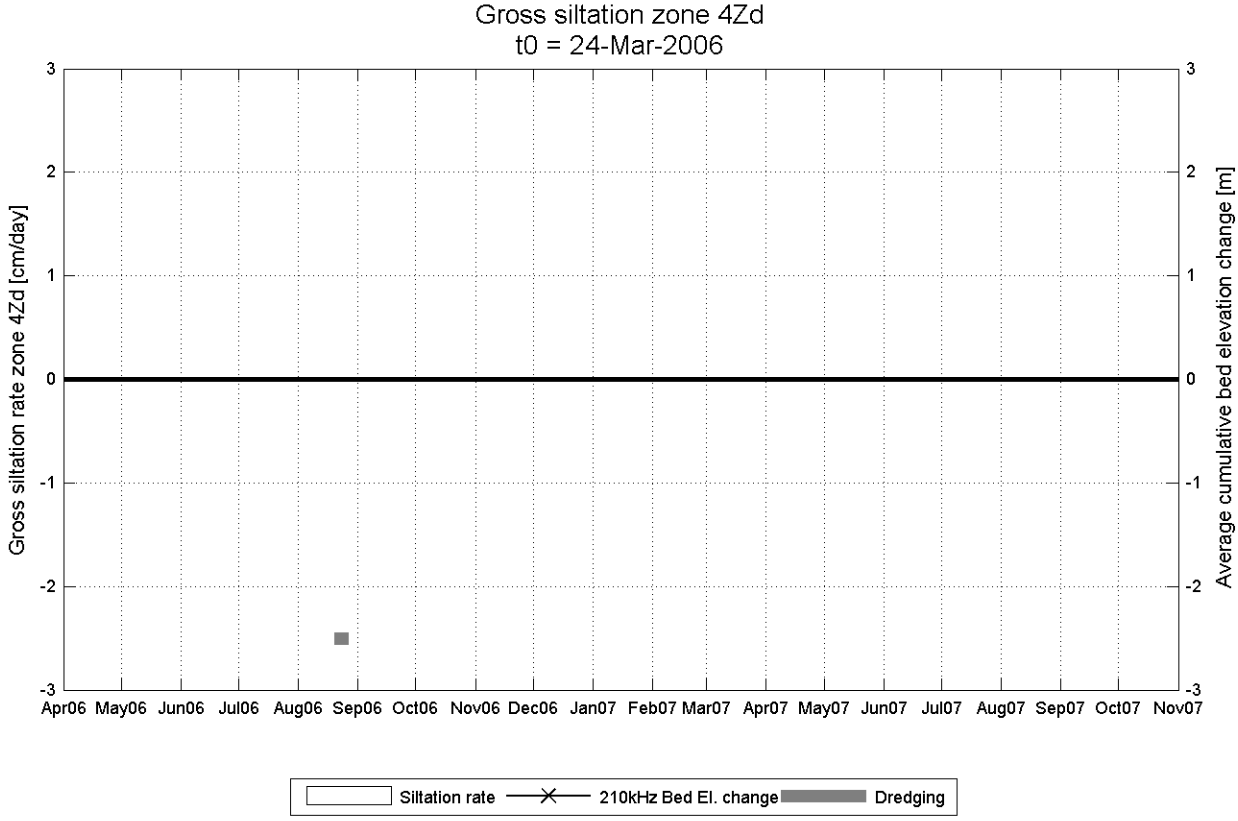
Equipment(s):

210kHz depth sounder

Location:

DGD





Reference level: depth sounding 24-Mar-2006

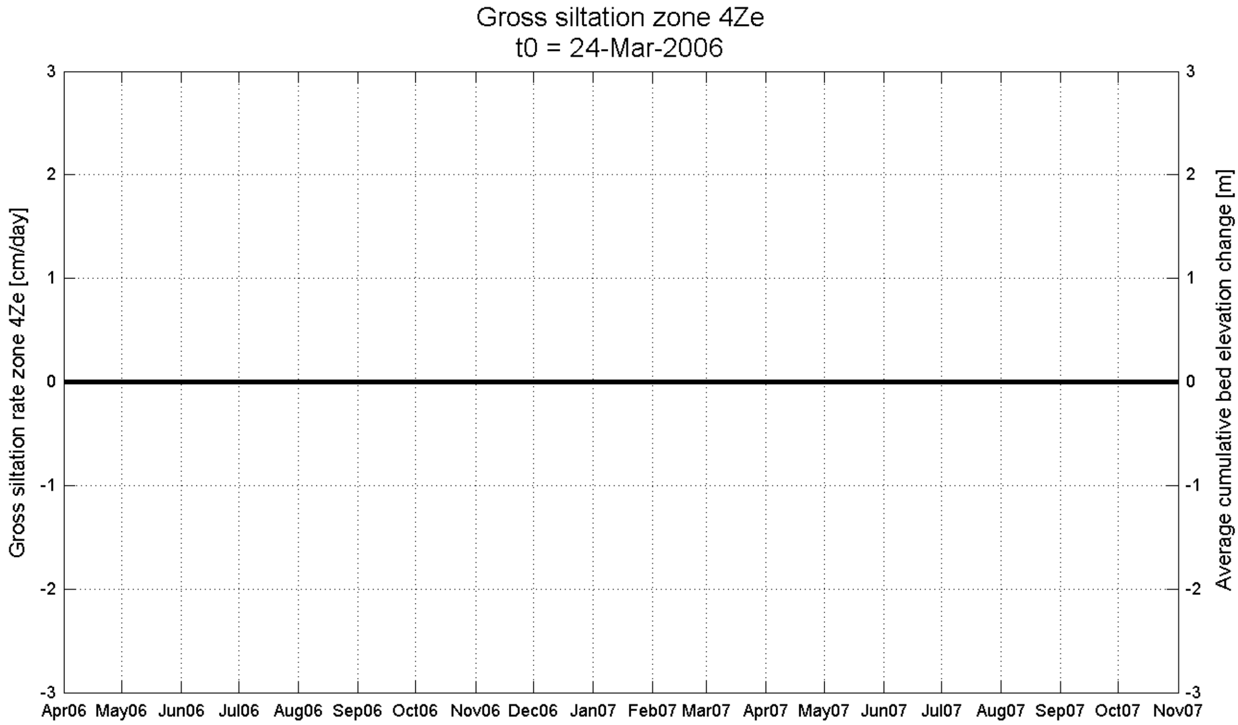
Data Processed by:

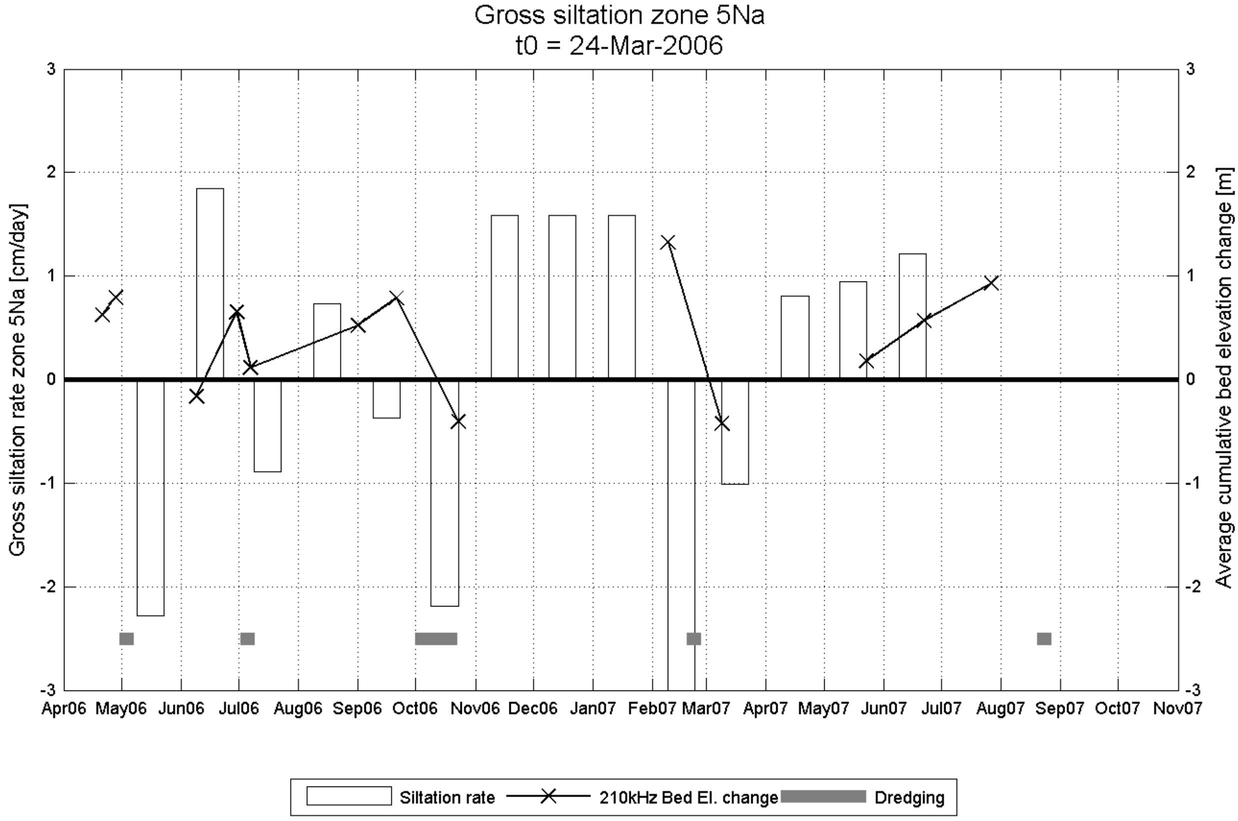
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





Reference level: depth sounding 24-Mar-2006

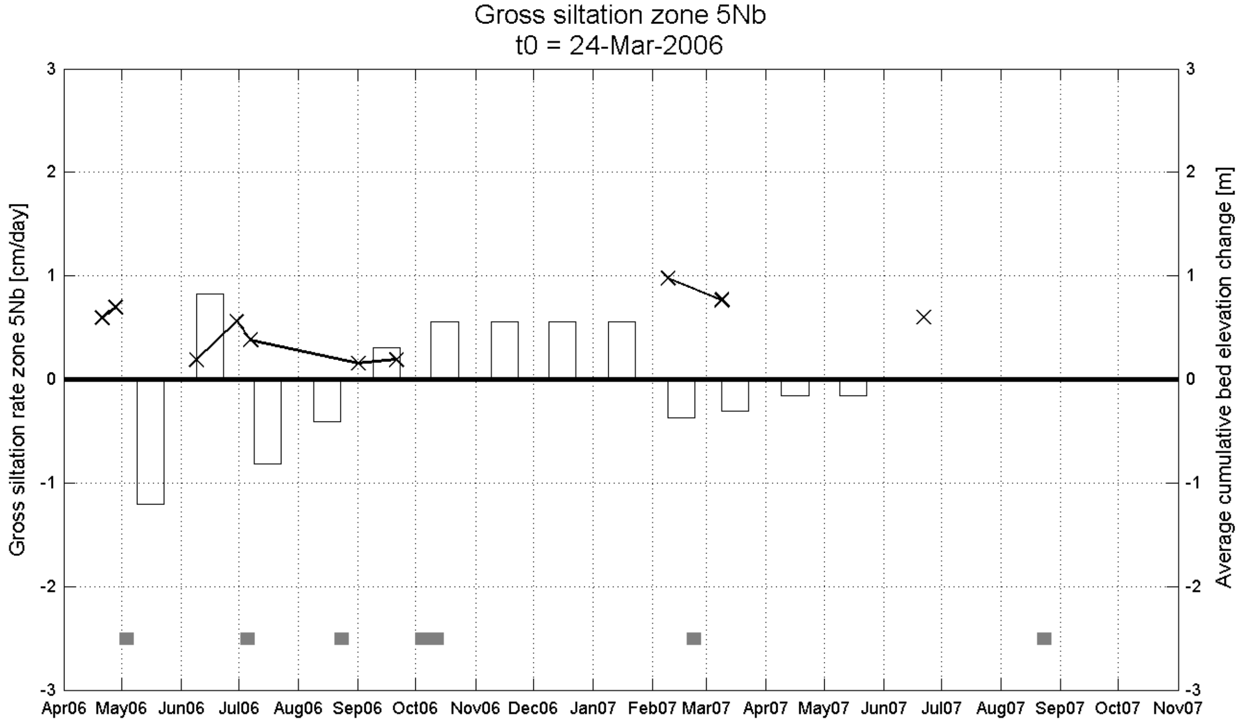
Data Processed by:

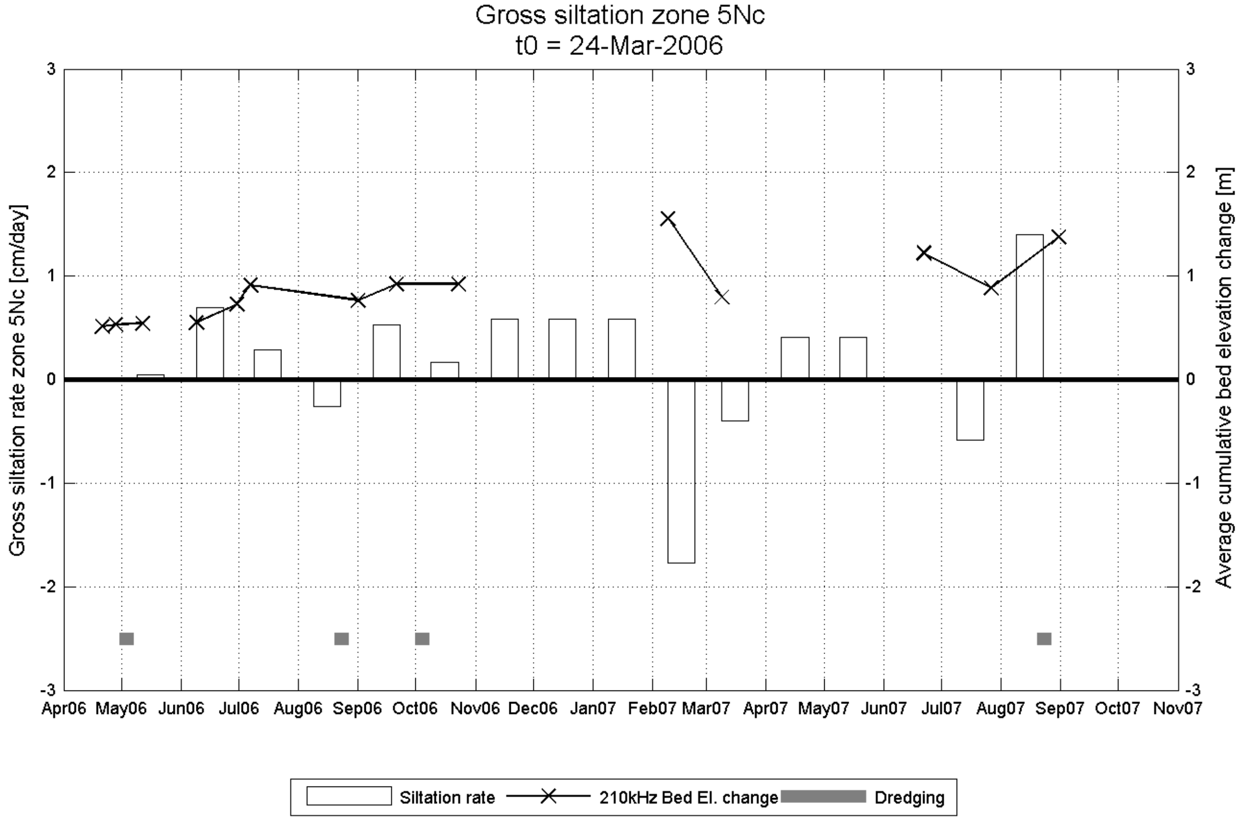
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





Reference level: depth sounding 24-Mar-2006

Data Processed by:

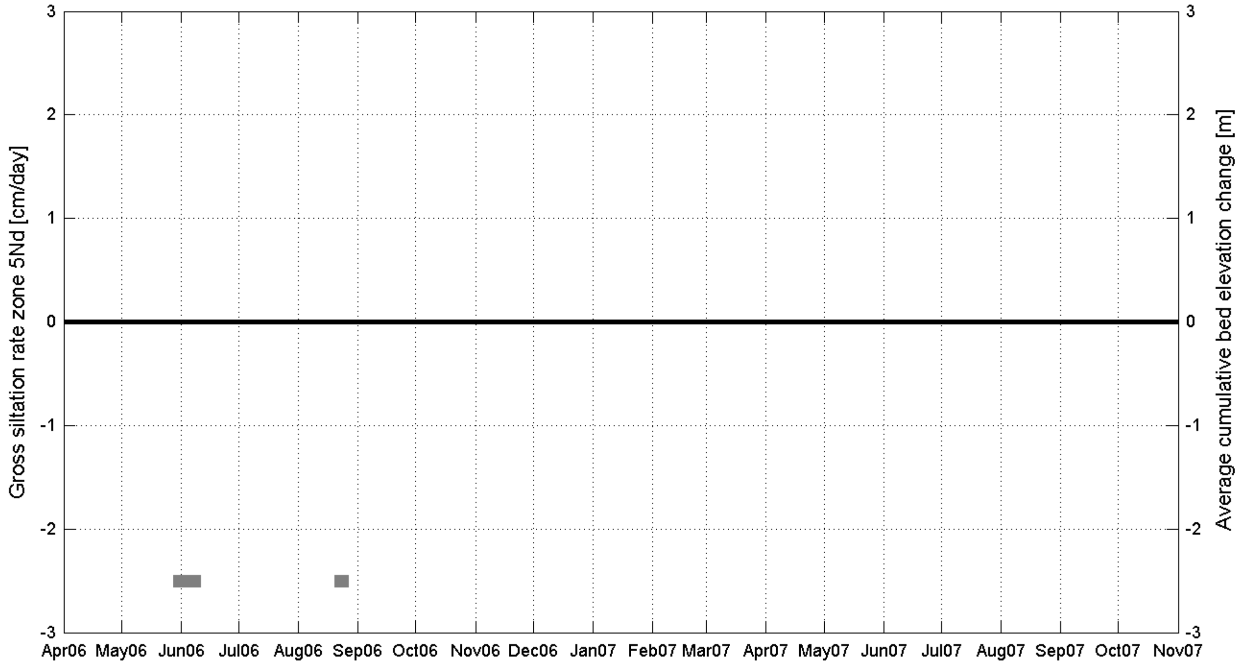
In association with :

I/RA/11283/07.081/MSA

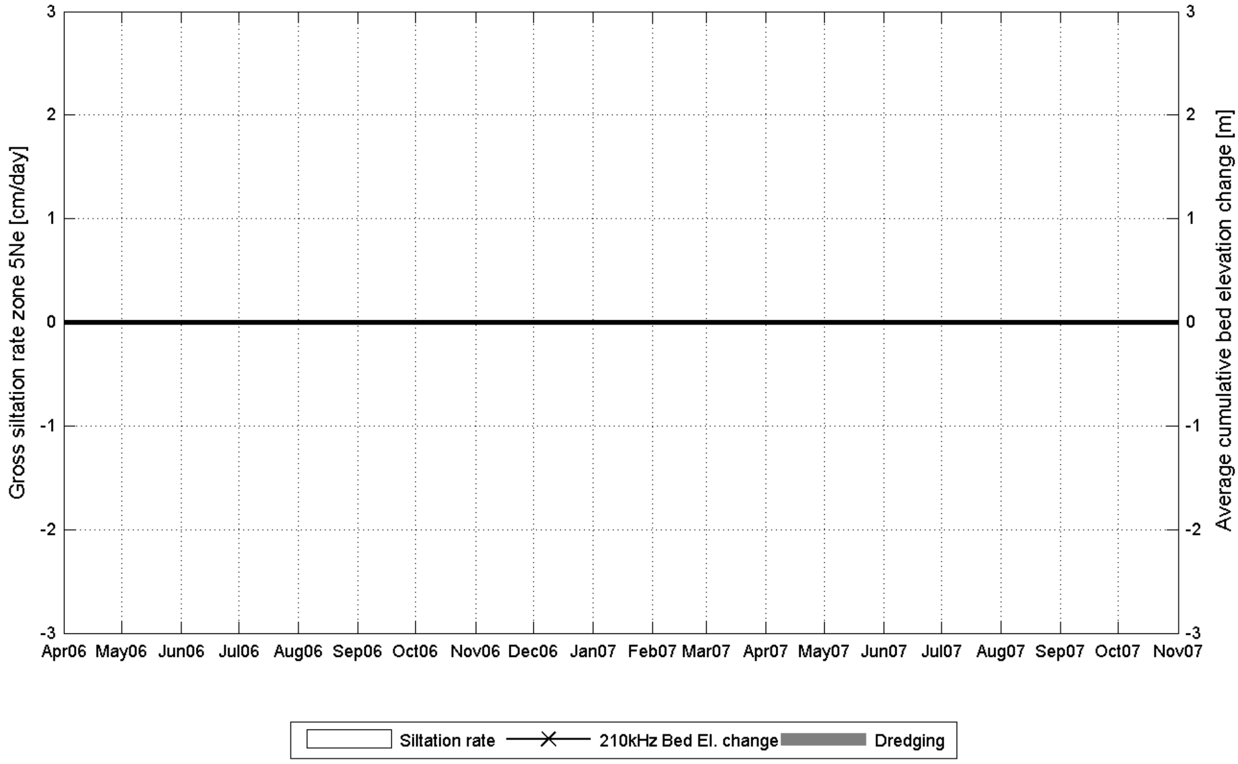
Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD

Gross siltation zone 5Nd
t0 = 24-Mar-2006



Gross siltation zone 5Ne
t0 = 24-Mar-2006



Reference level: depth sounding 24-Mar-2006

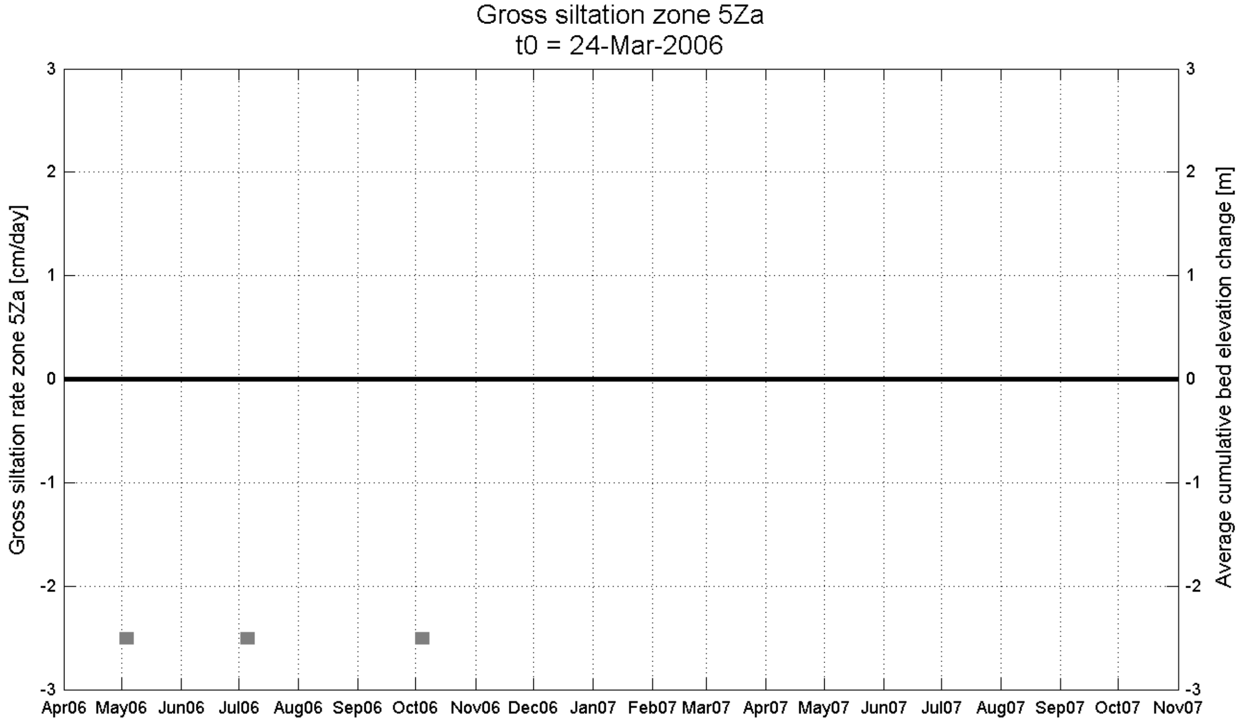
Data Processed by: IMDC

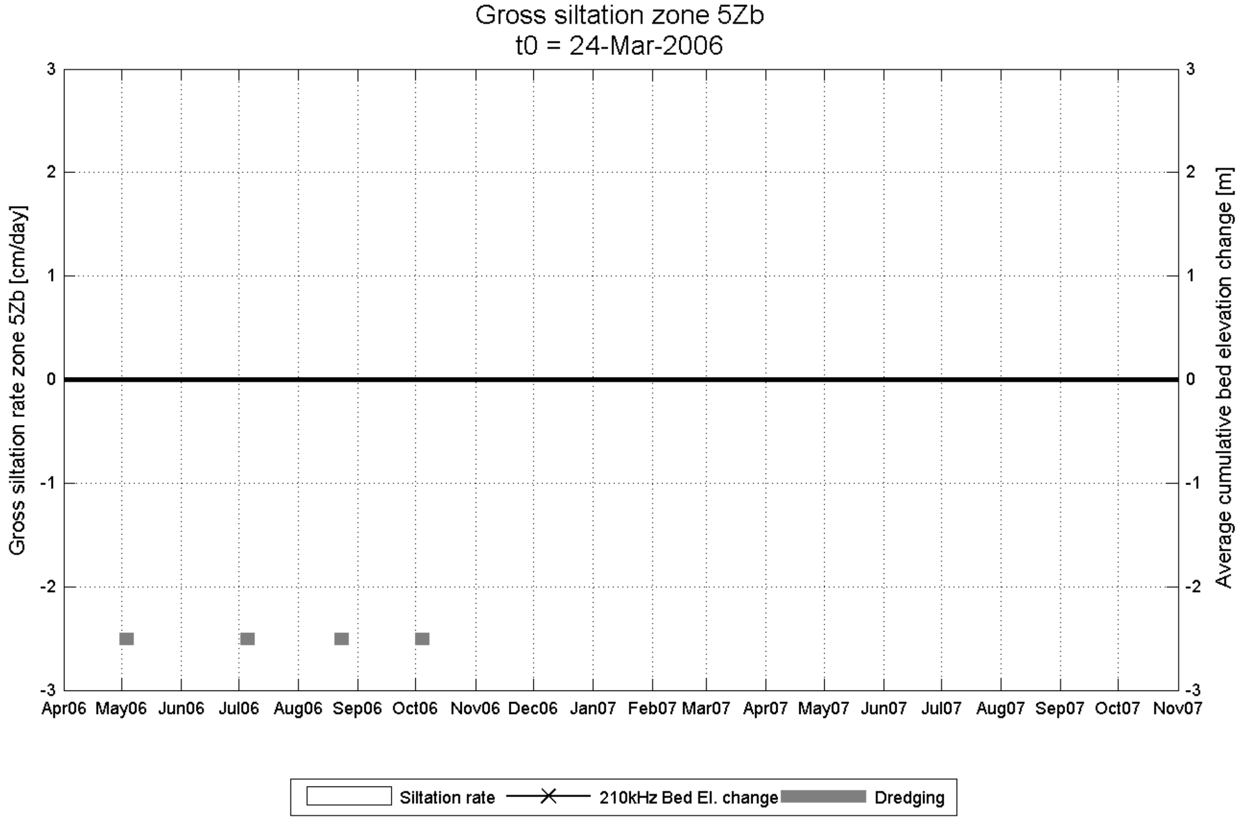
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





Reference level: depth sounding 24-Mar-2006

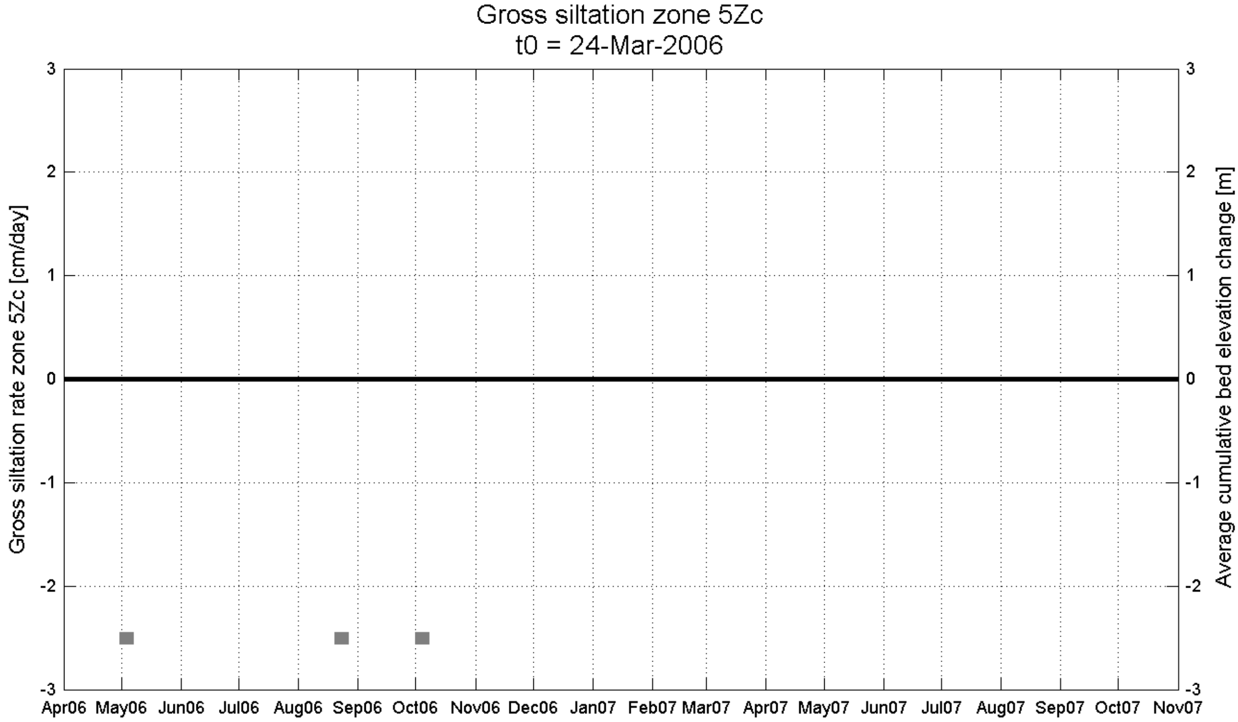
Data Processed by: IMDC

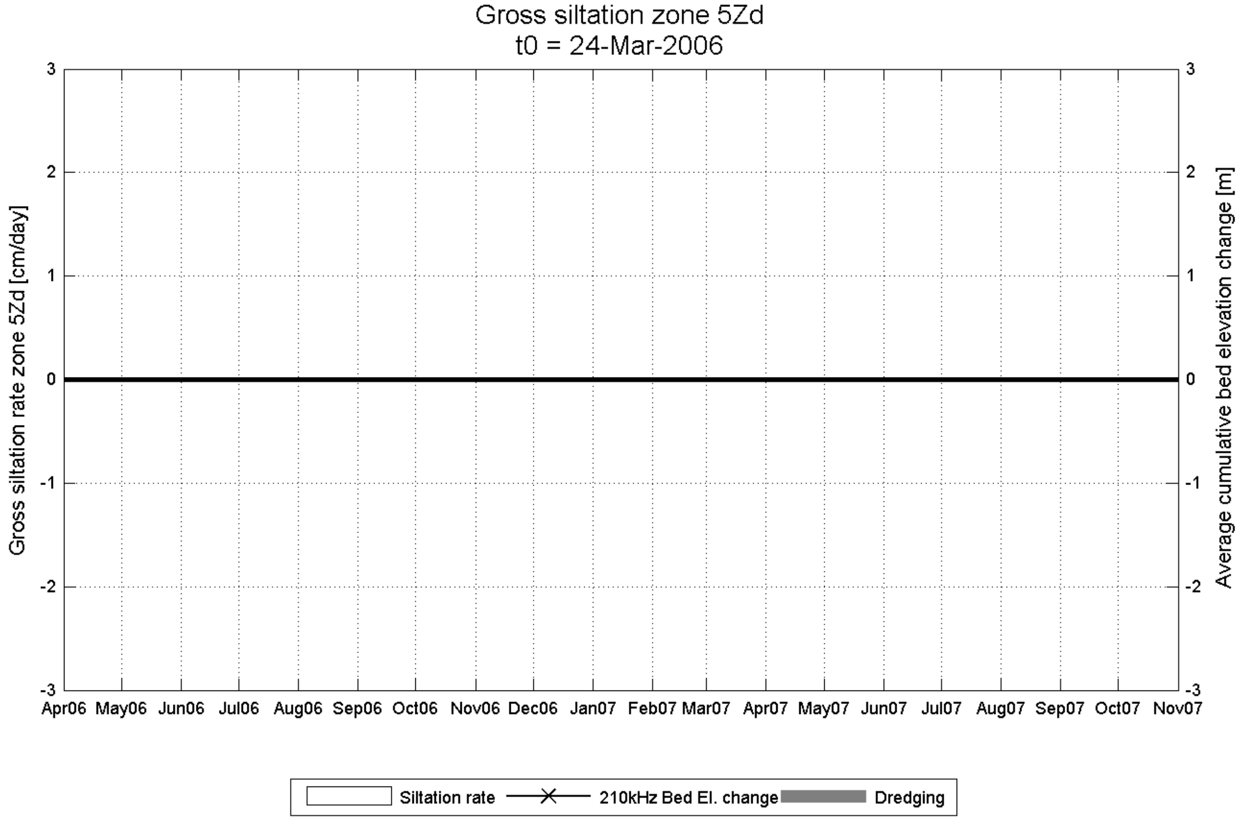
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





Reference level: depth sounding 24-Mar-2006

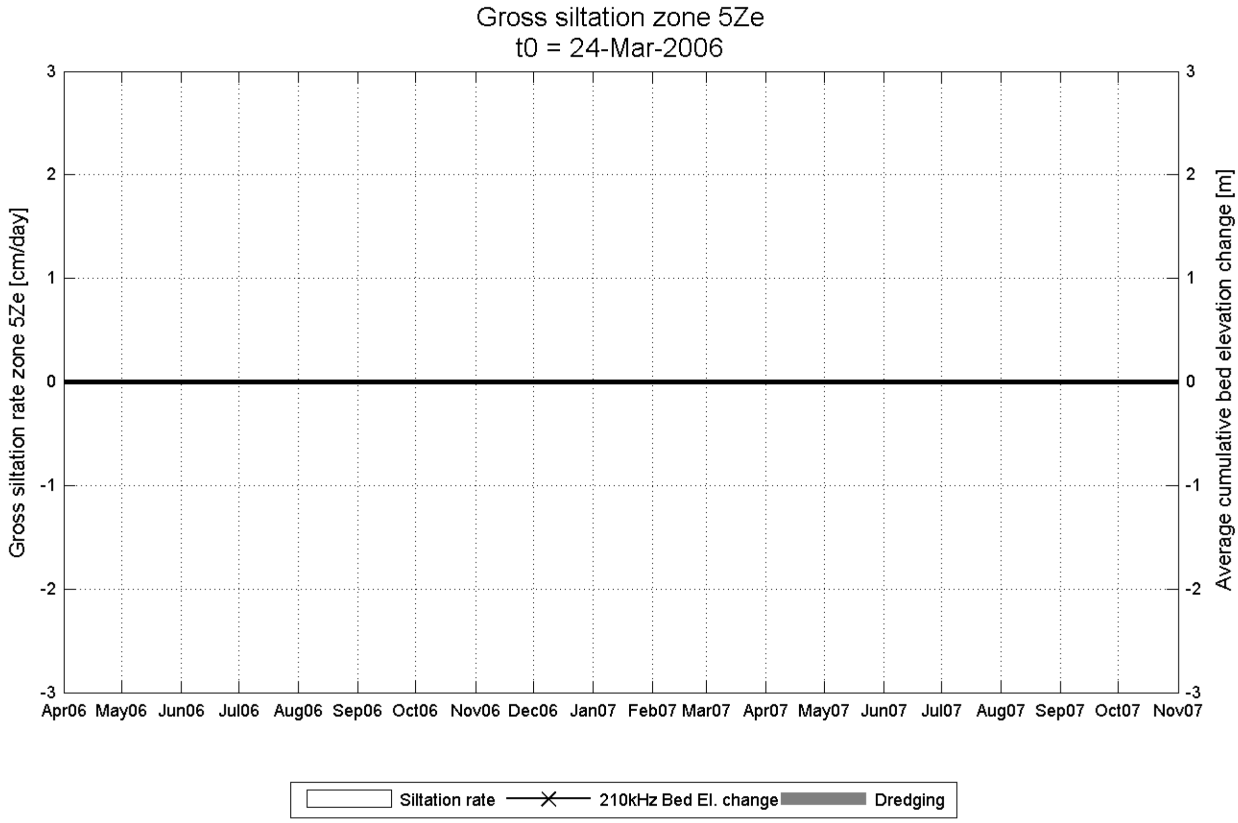
Data Processed by: IMDC

In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



Reference level: depth sounding 24-Mar-2006

Data Processed by: IMDC

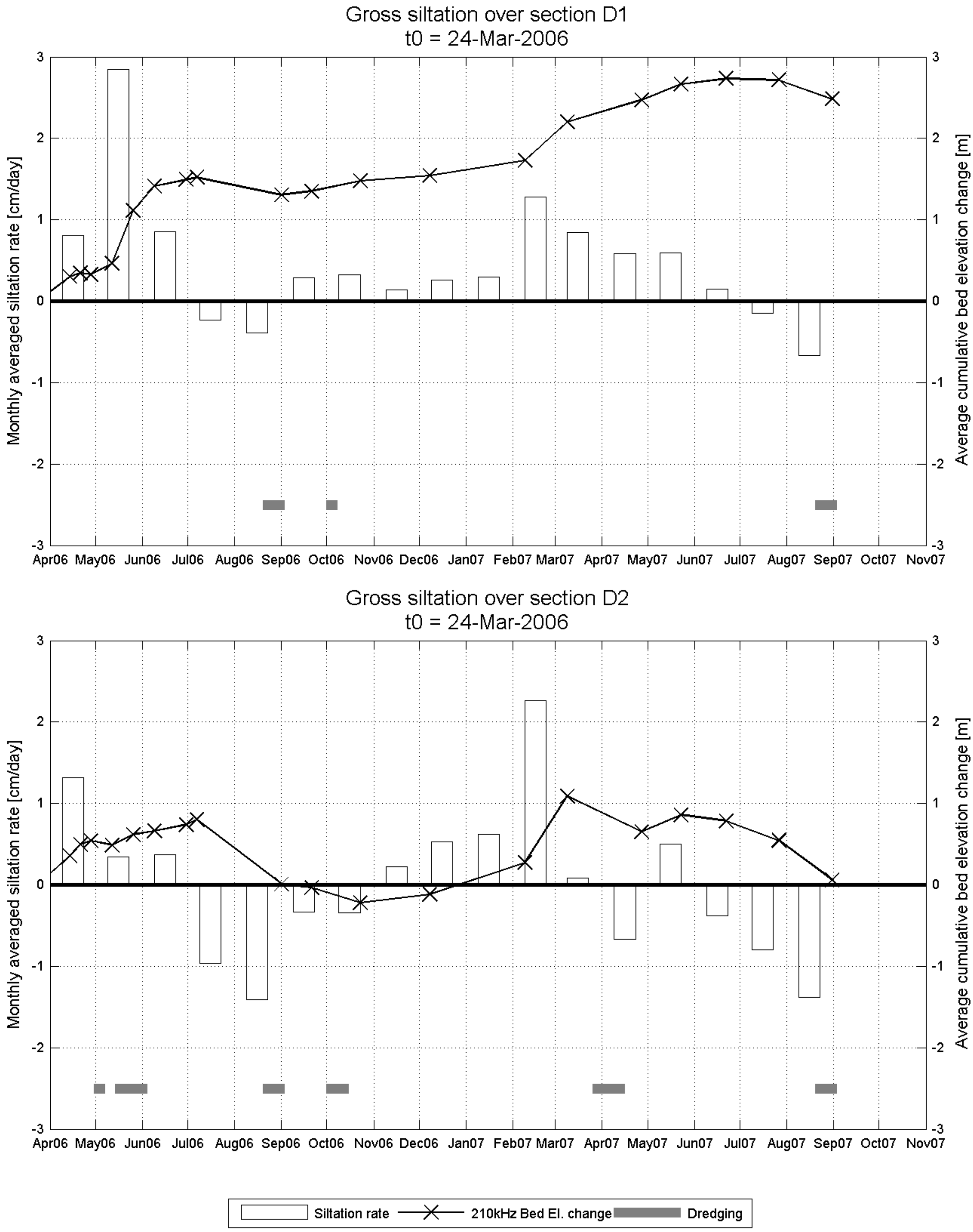
In association with :

I/RA/11283/07.081/MSA

C.3 Water-bed interface evolution for all sections

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



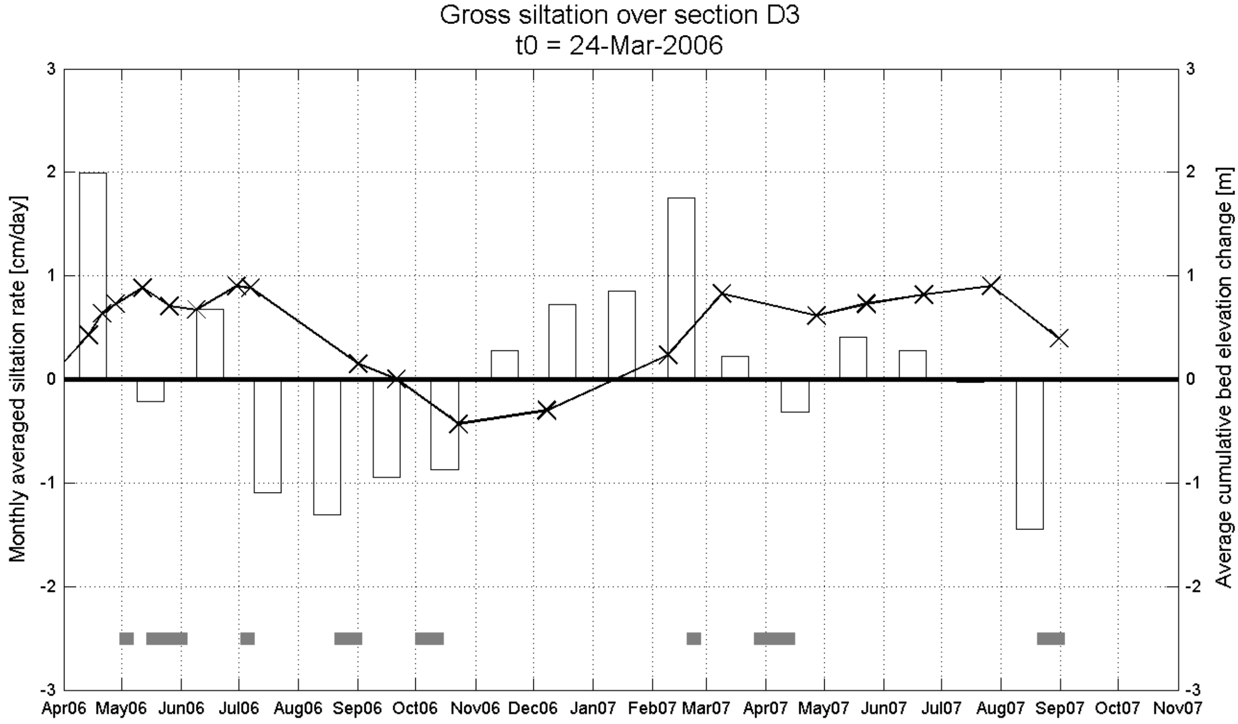
Reference level: depth sounding 24-Mar-2006

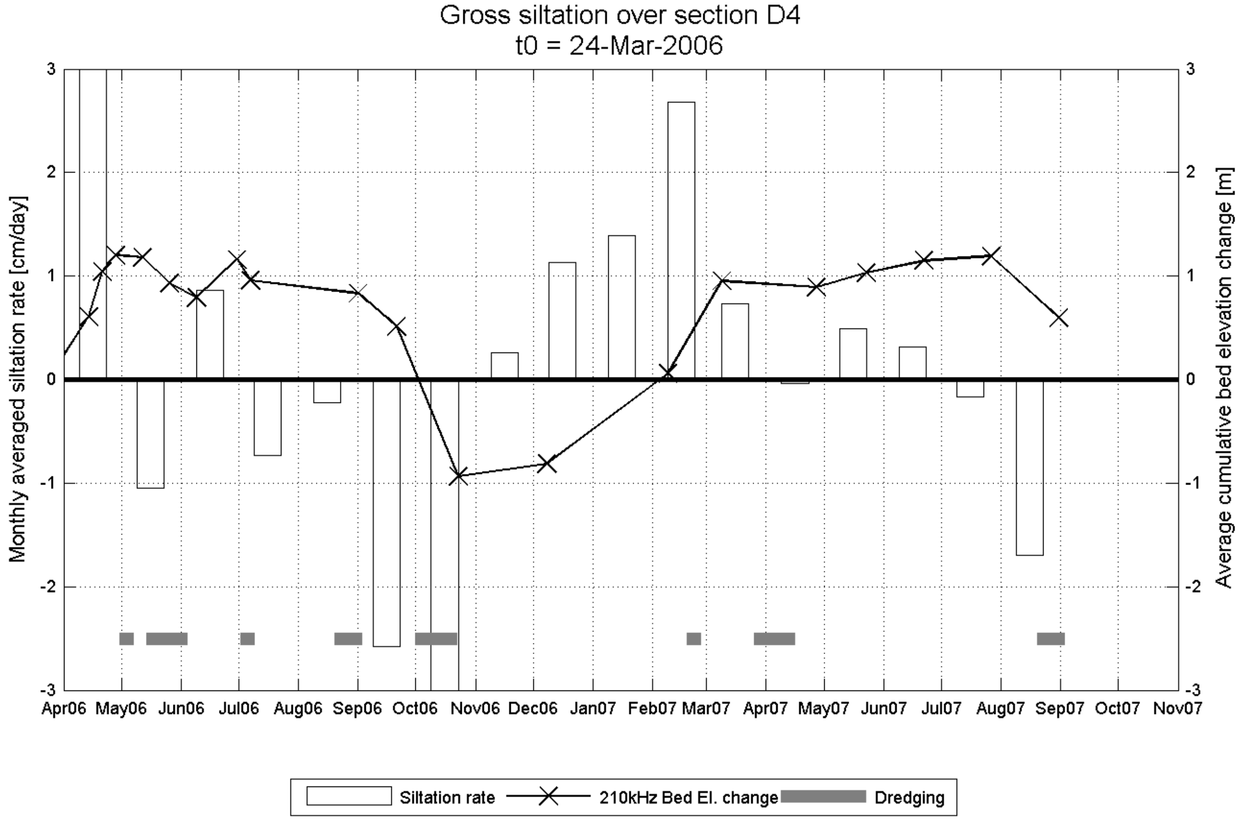
Data Processed by: IMDC

In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok	
Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD

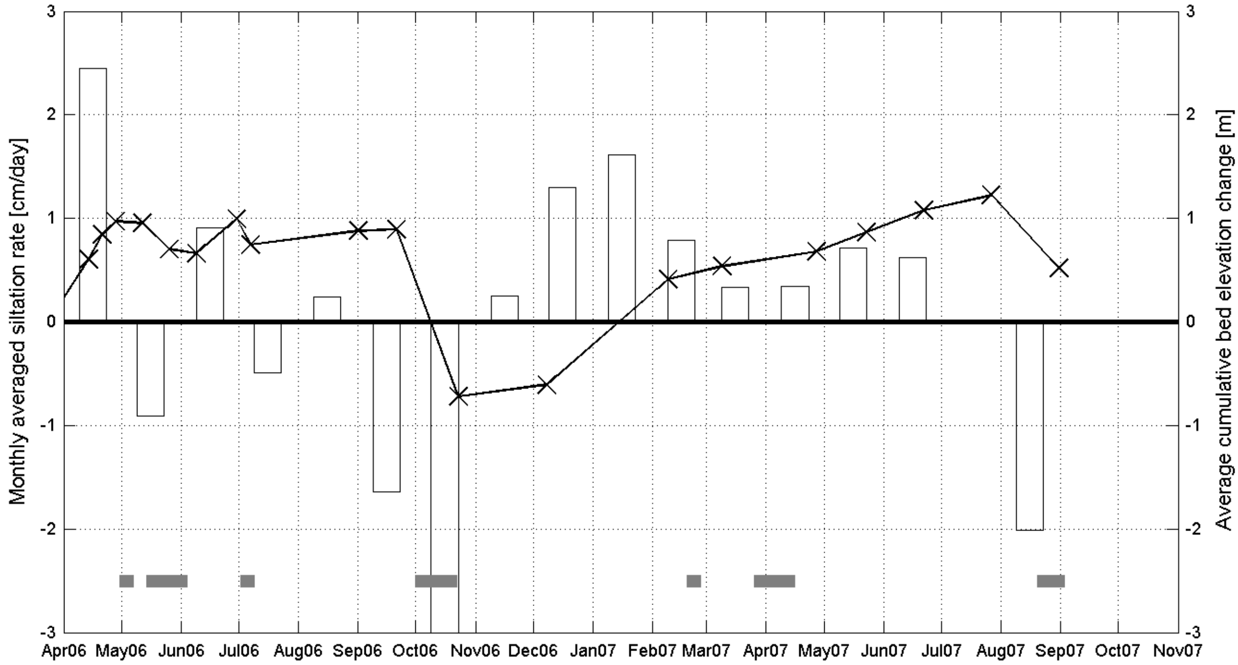


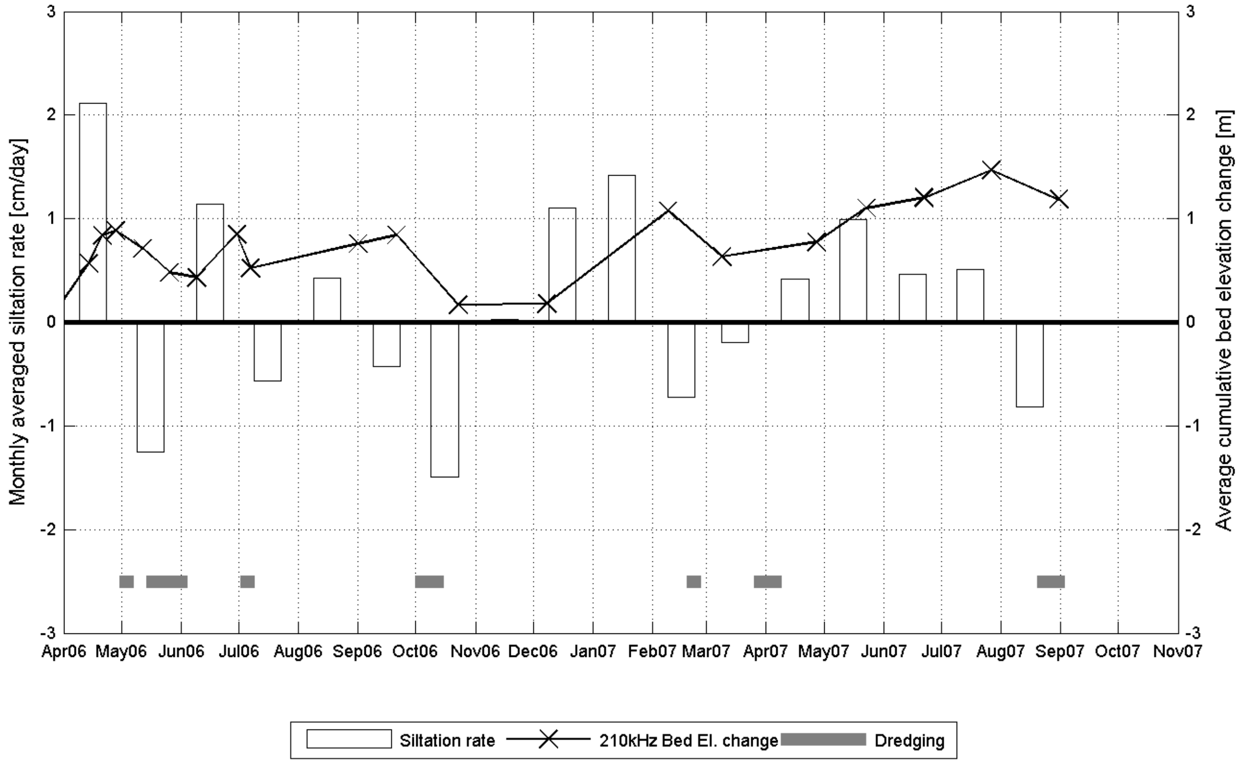


Reference level: depth sounding 24-Mar-2006	Data Processed by: IMDC In association with : I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





Reference level: depth sounding 24-Mar-2006

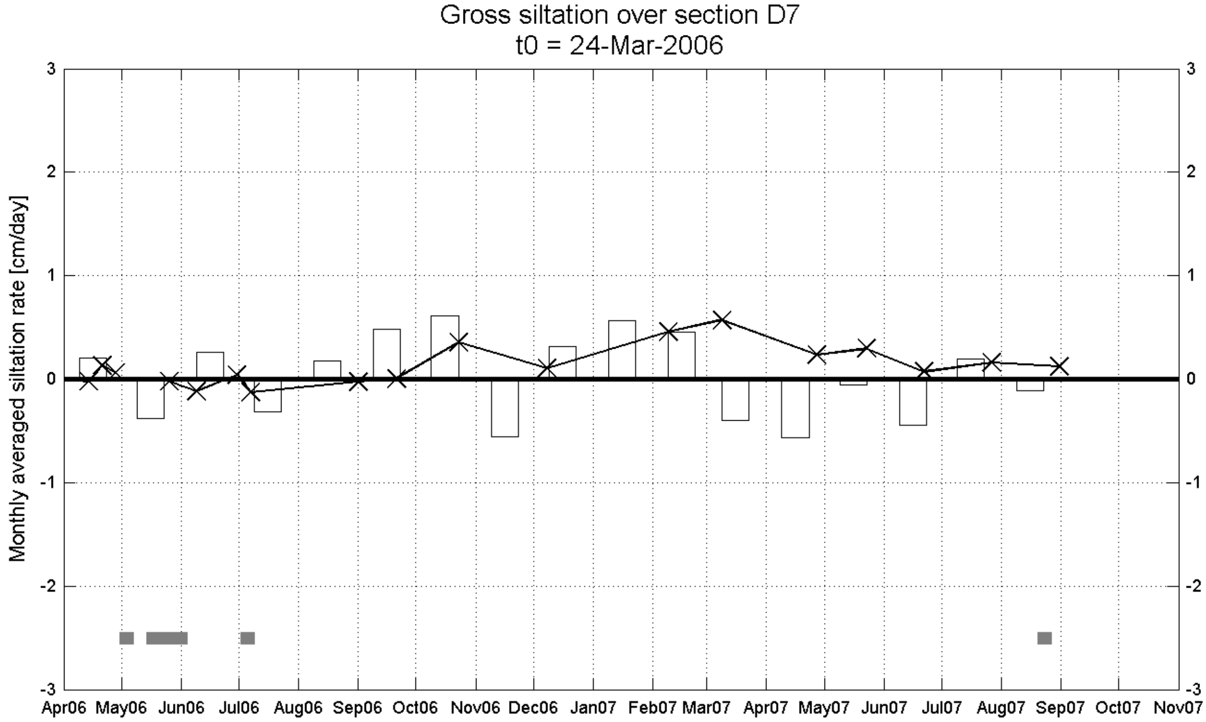
Data Processed by:

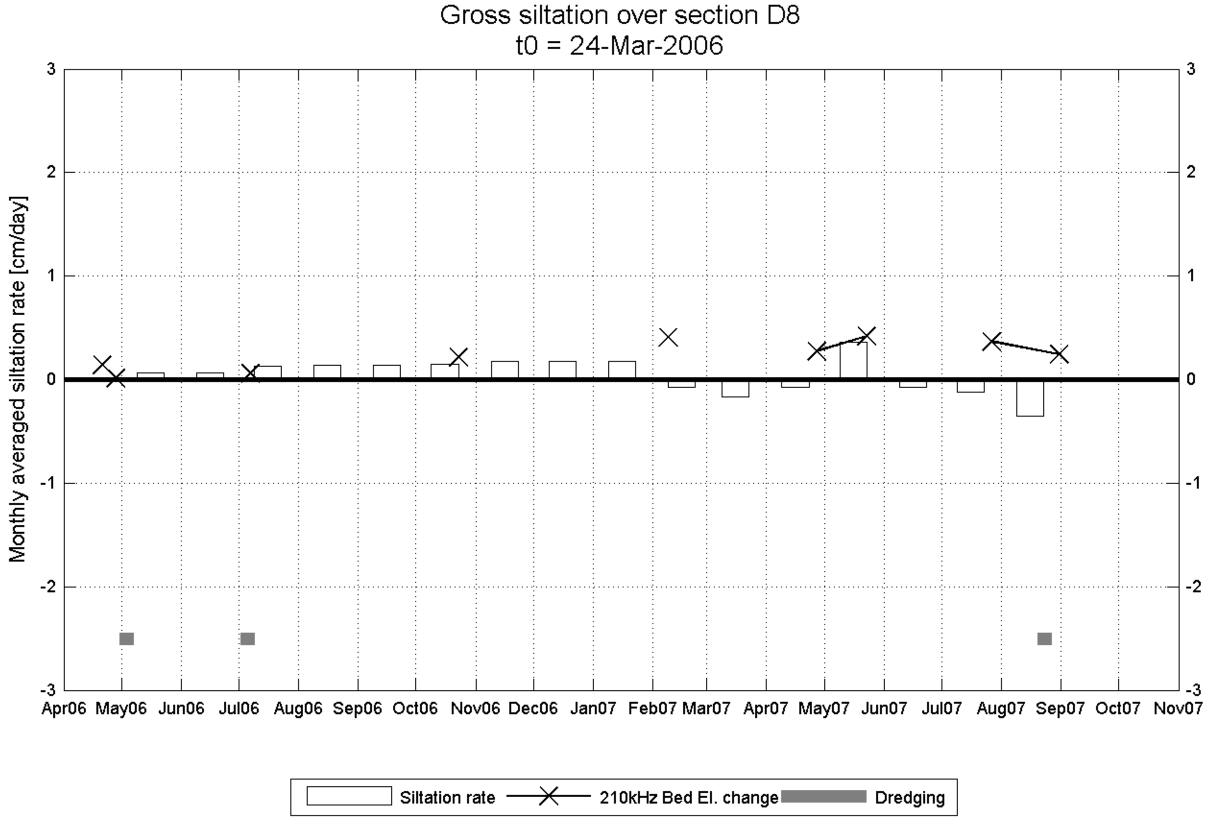
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



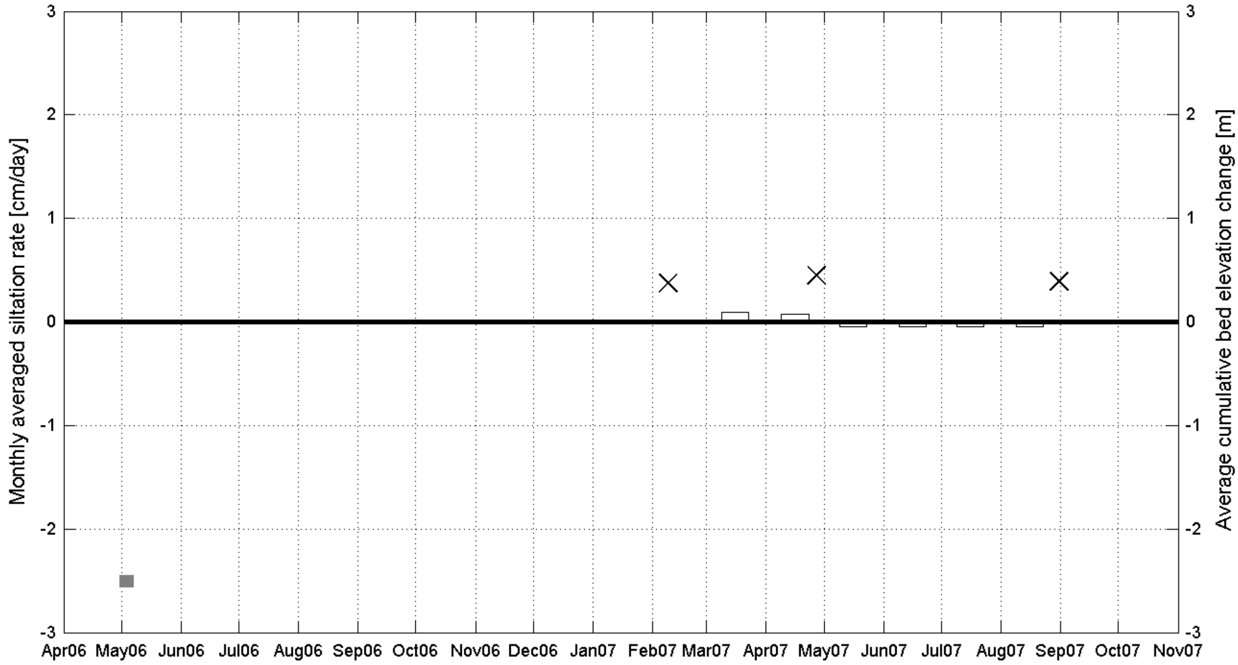


Reference level: depth sounding 24-Mar-2006	Data Processed by: In association with : I/RA/11283/07.081/MSA

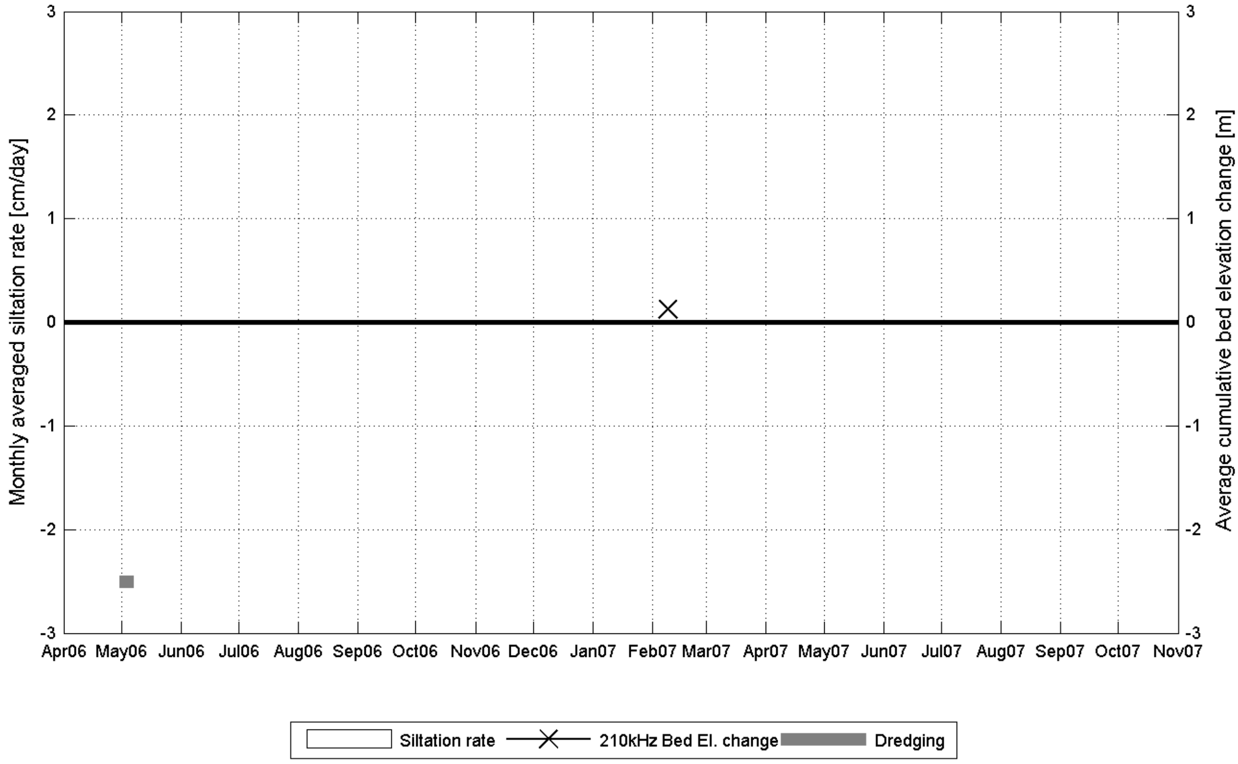
Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD

Gross siltation over section D9
t0 = 24-Mar-2006



Gross siltation over section D10
t0 = 24-Mar-2006



Reference level: depth sounding 24-Mar-2006

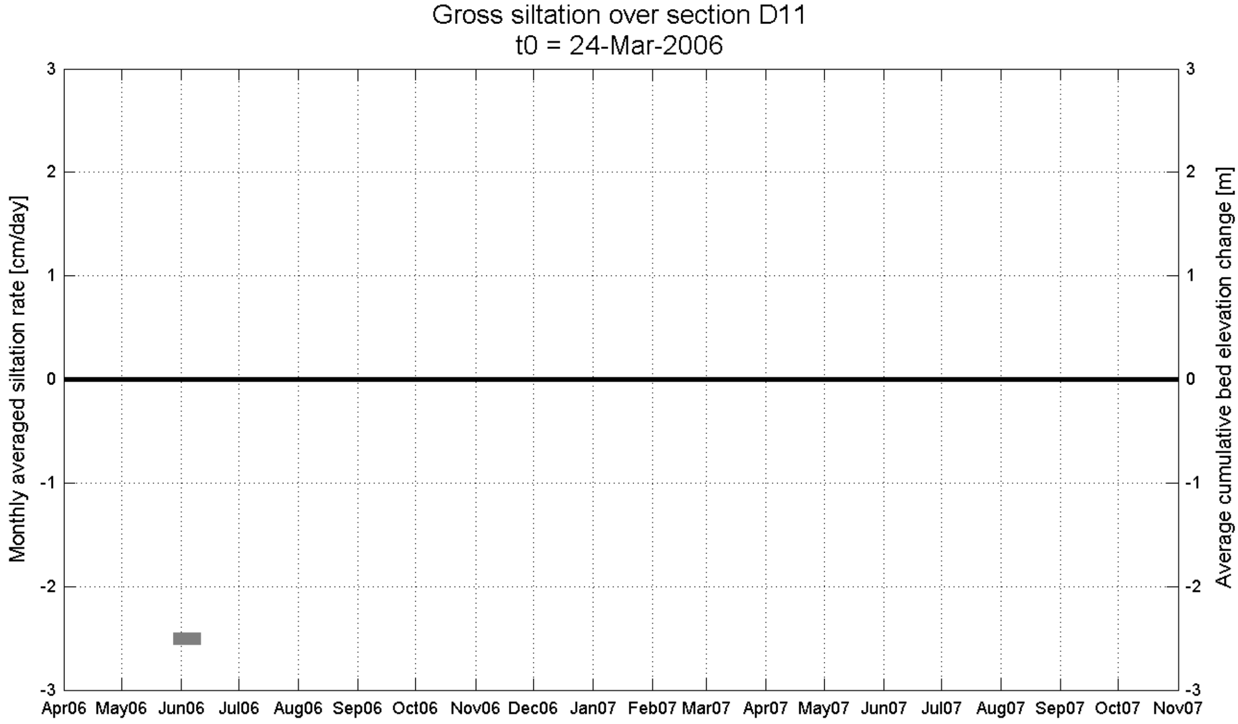
Data Processed by:

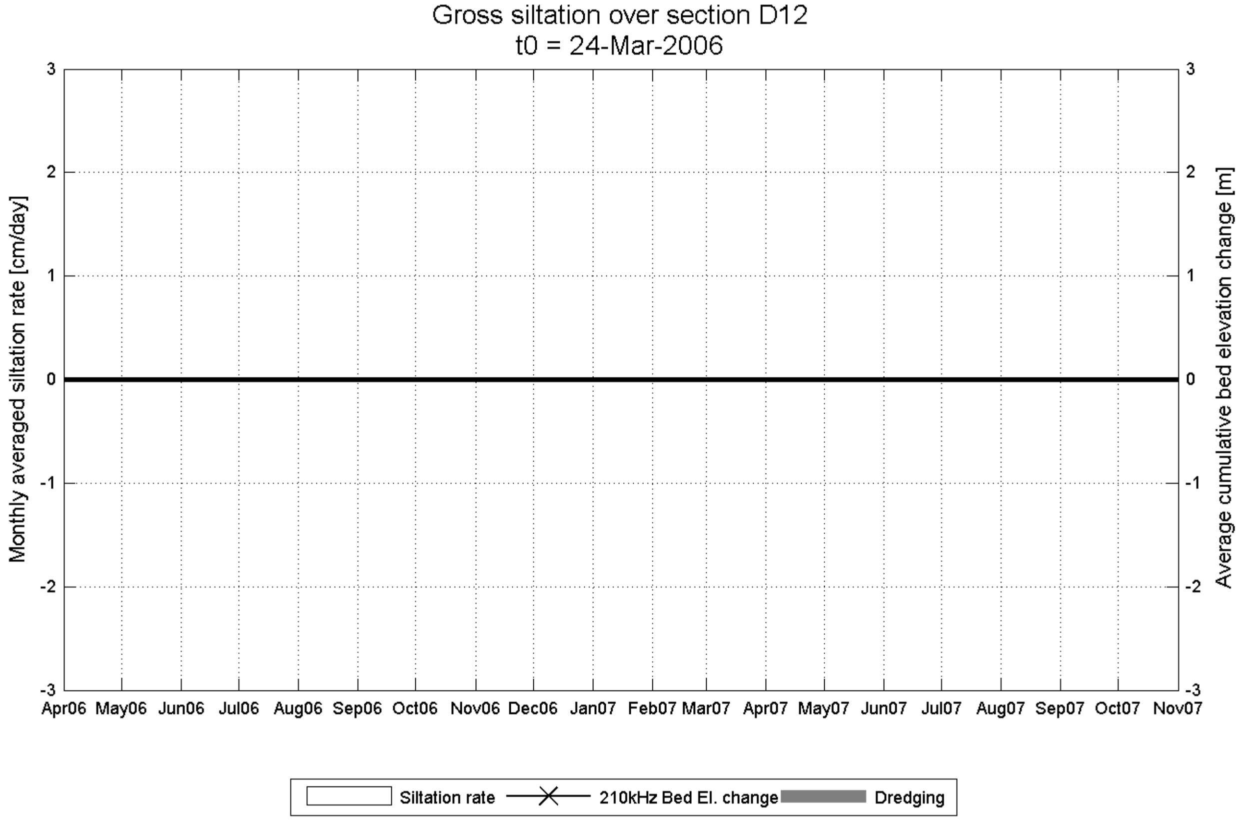
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



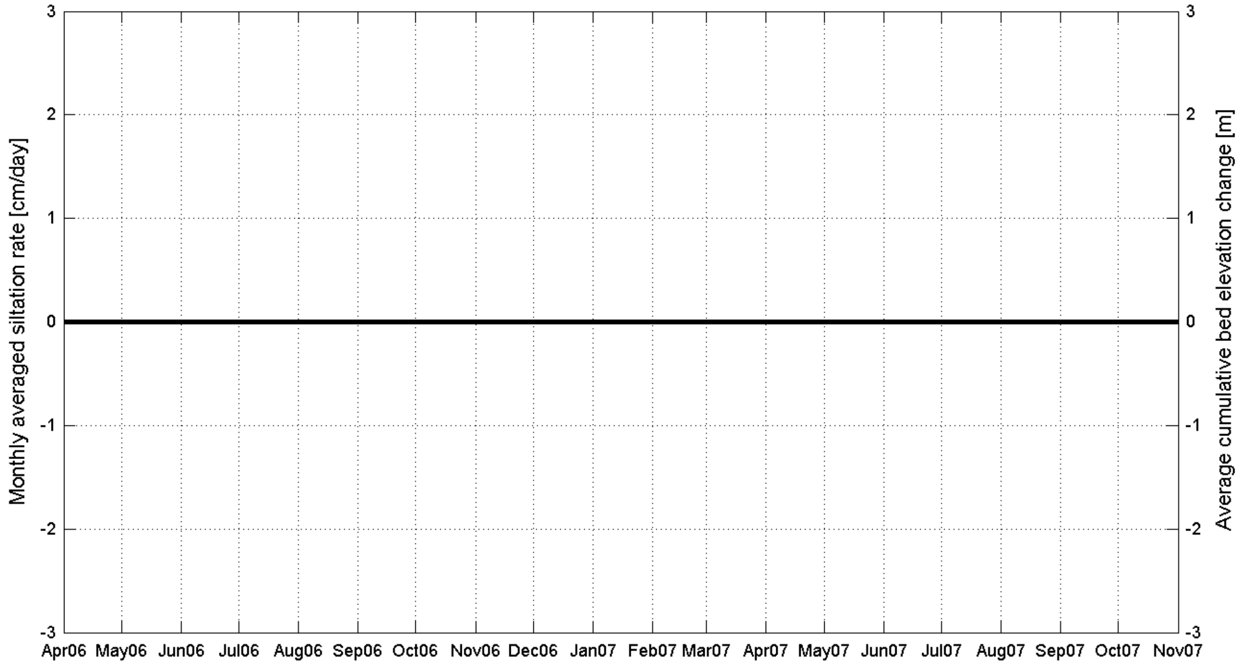


Reference level: depth sounding 24-Mar-2006	Data Processed by: IMDC In association with : I/RA/11283/07.081/MSA

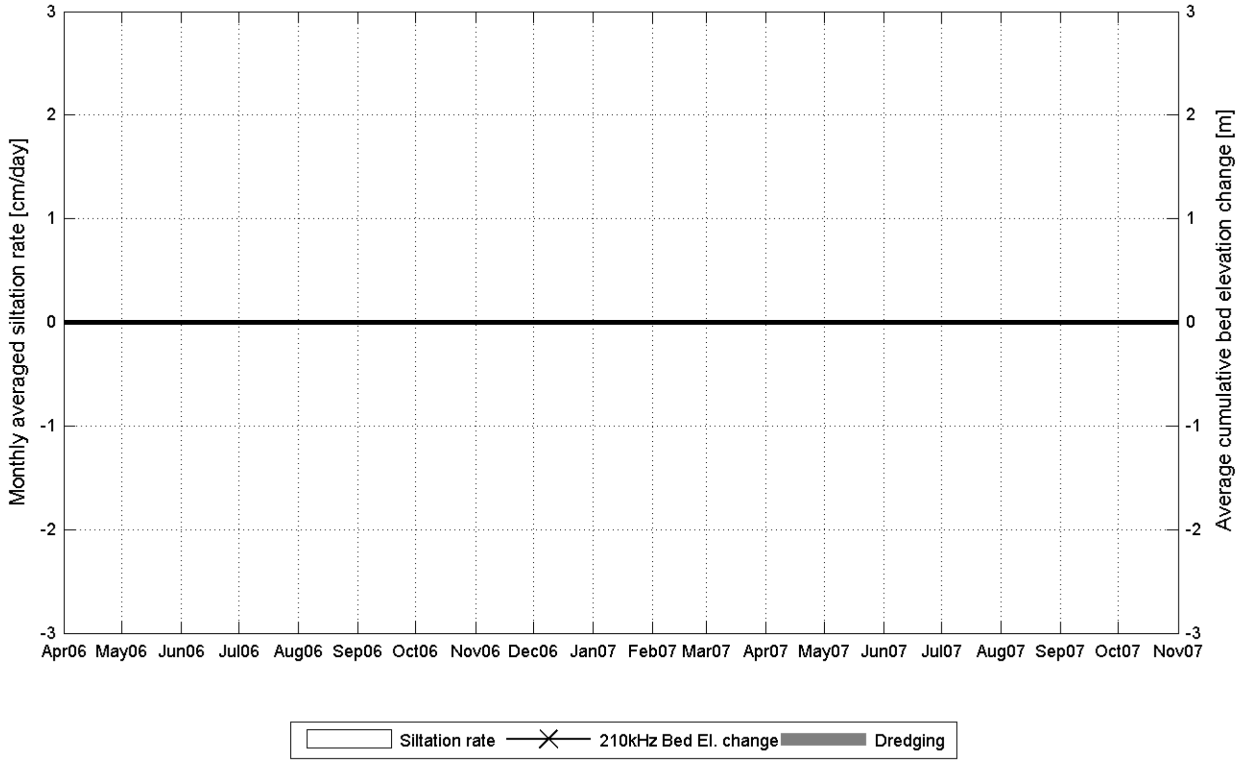
Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD

Gross siltation over section D13
t0 = 24-Mar-2006



Gross siltation over section D14
t0 = 24-Mar-2006



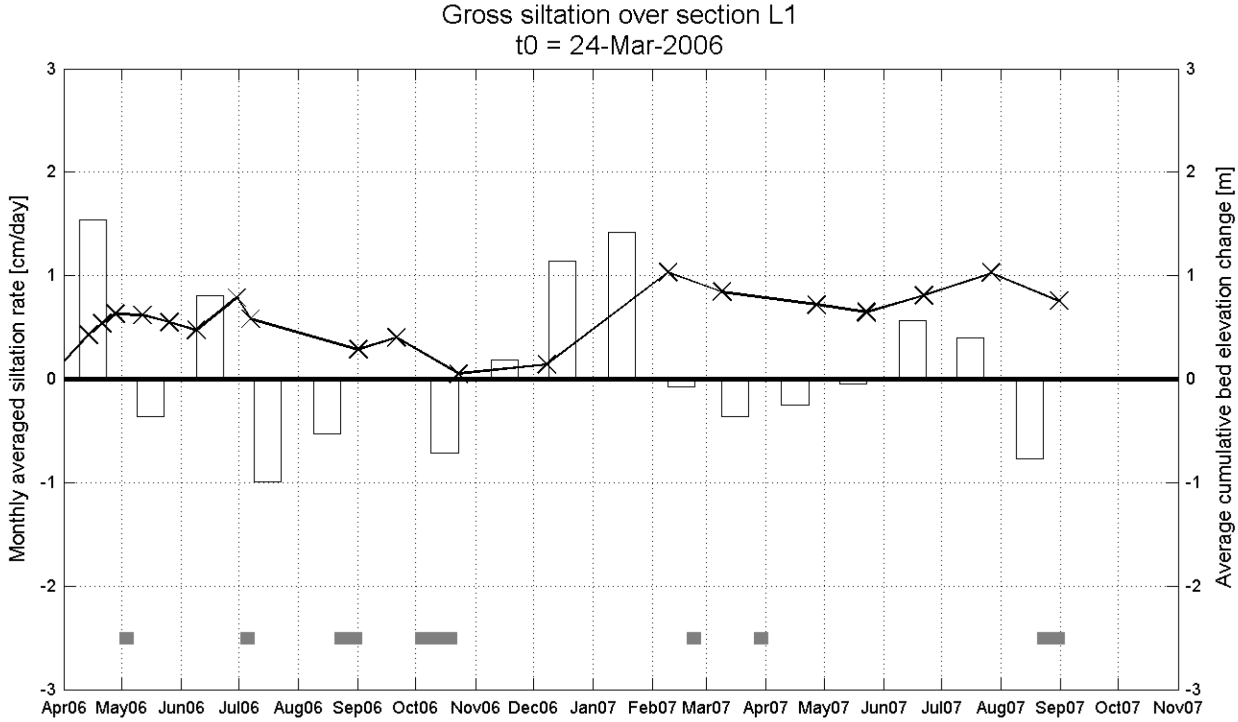
Reference level: depth sounding 24-Mar-2006

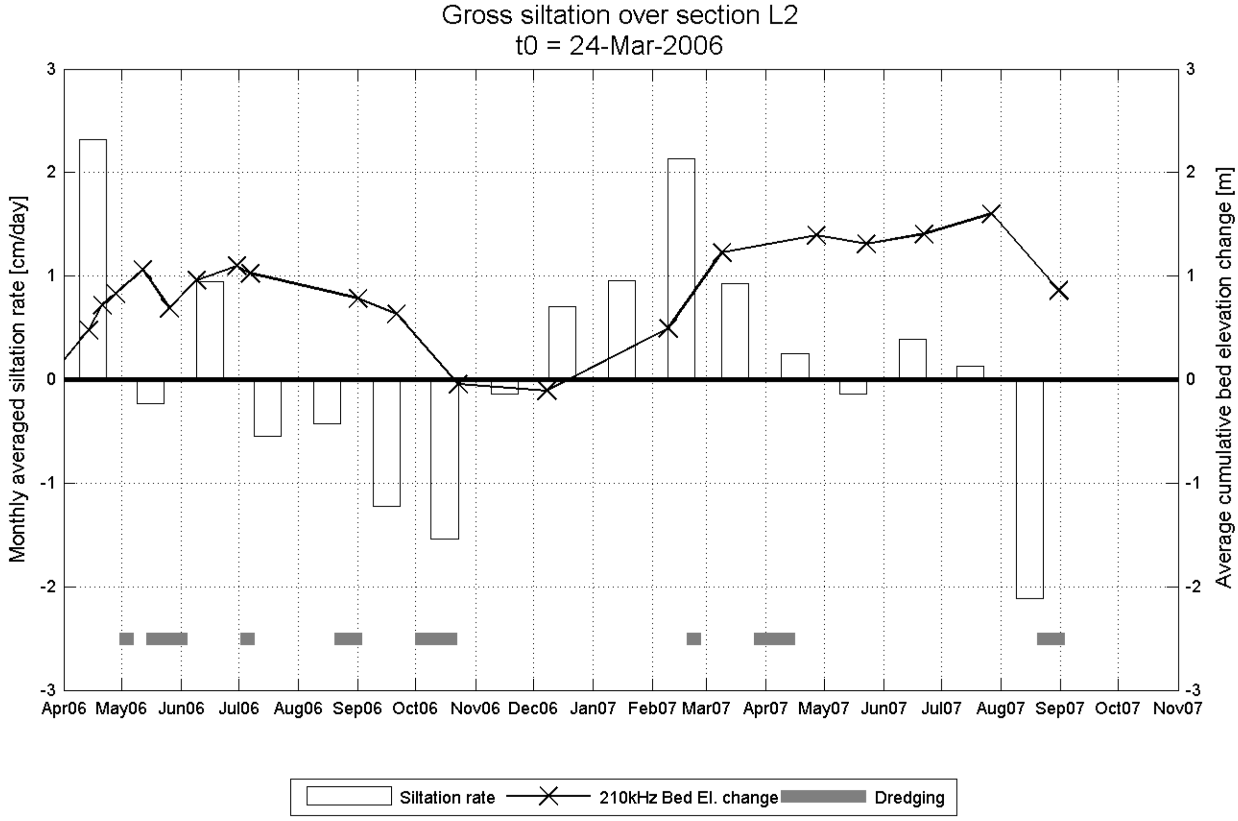
Data Processed by:
In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD





Reference level: depth sounding 24-Mar-2006

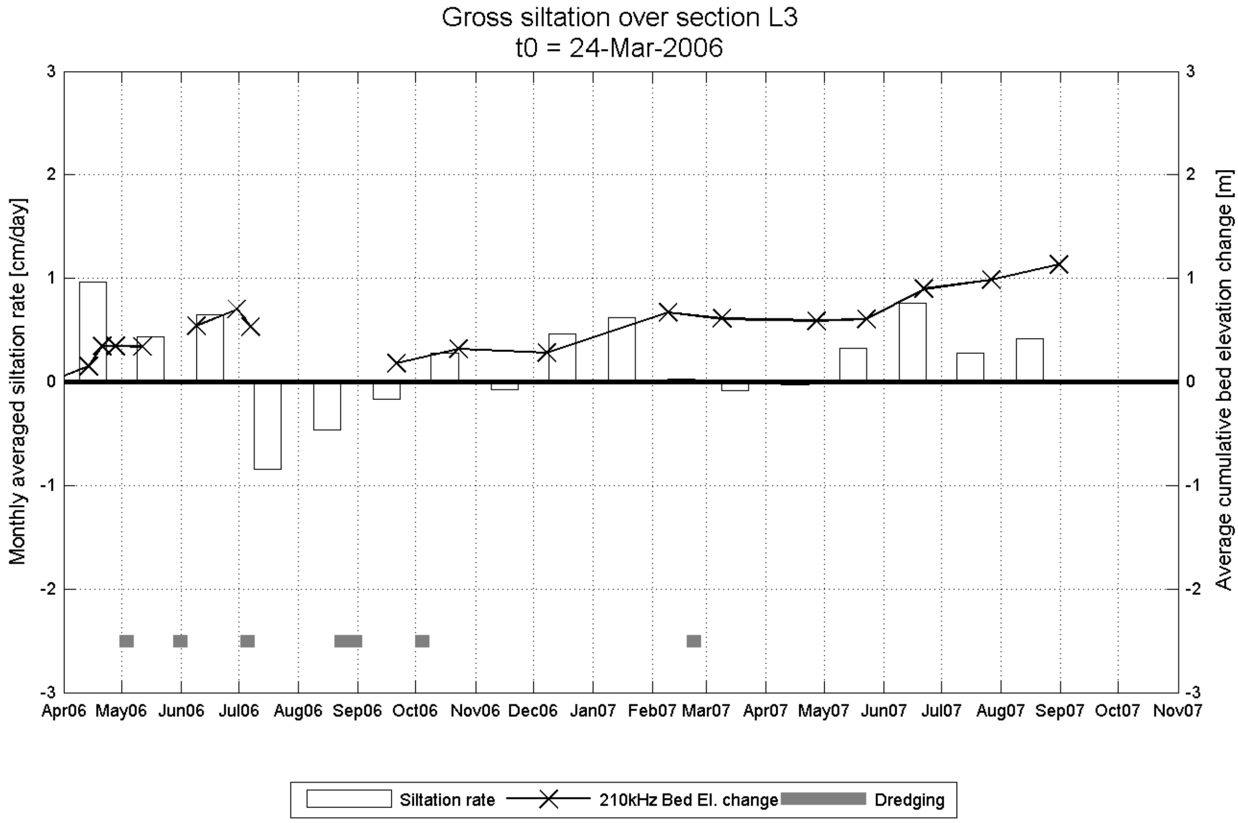
Data Processed by:

In association with :

I/RA/11283/07.081/MSA

Long-term monitoring siltation Deurganckdok

Siltation height / monthly gross siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



Reference level: depth sounding 24-Mar-2006

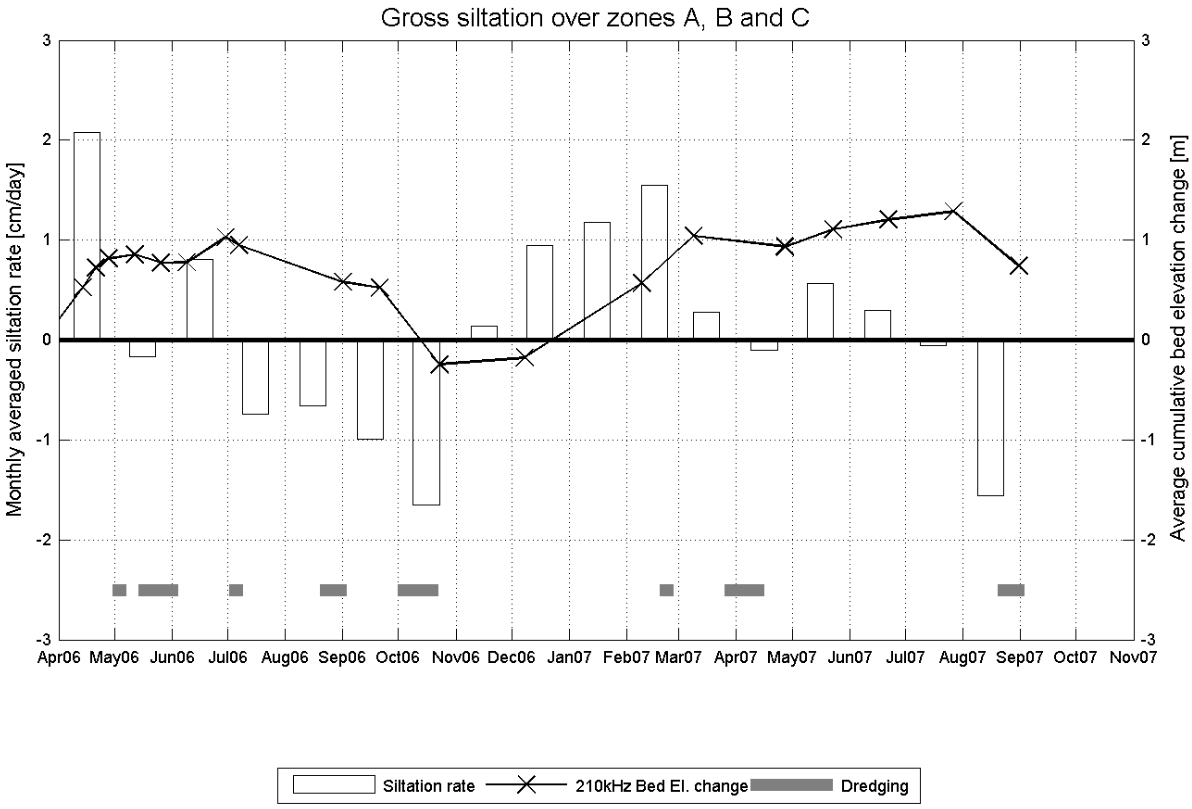
Data Processed by: IMDC

In association with :

I/RA/11283/07.081/MSA

C.4 Siltation rate complete Deurganckdok

Long-term monitoring siltation Deurganckdok	
Siltation height / monthly siltation rate	Equipment(s): 210kHz depth sounder
	Location: DGD



Gross siltation for zones 3A/3B/4A/4B/5A/5B
Reference level: depth sounding 24-Mar-2006

Data Processed by: IMDC
In association with :

I/RA/11283/07.081/MSA

APPENDIX D.

DREDGED MASS

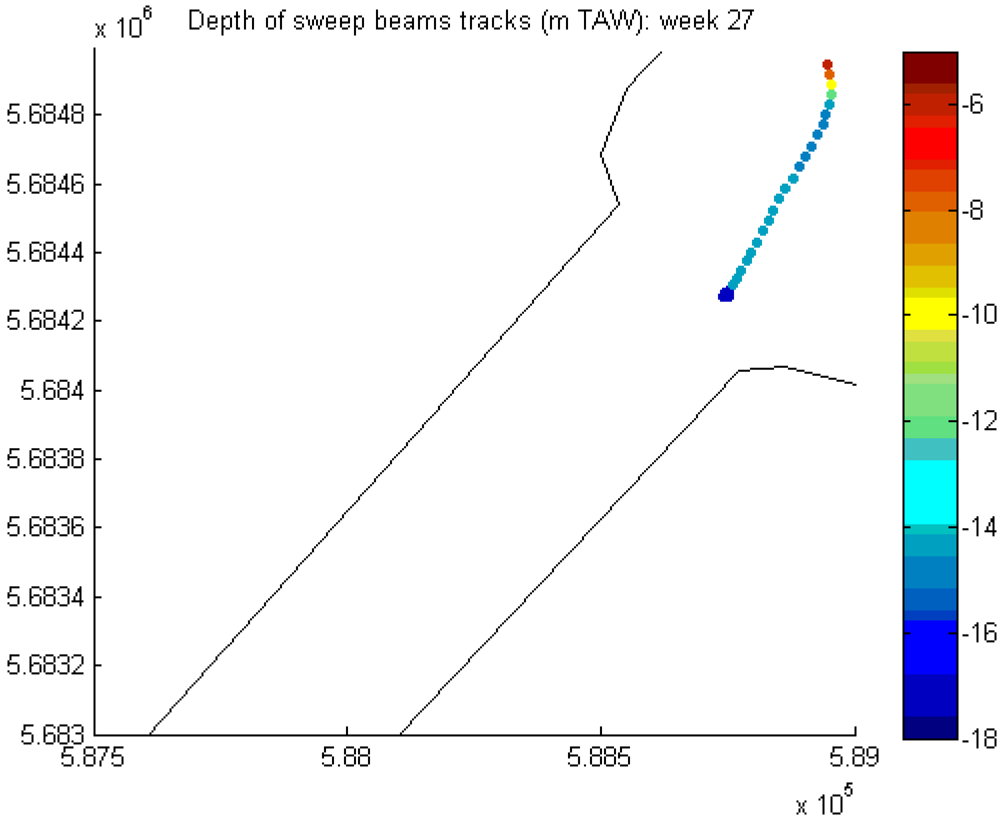
D.1 Tabular results

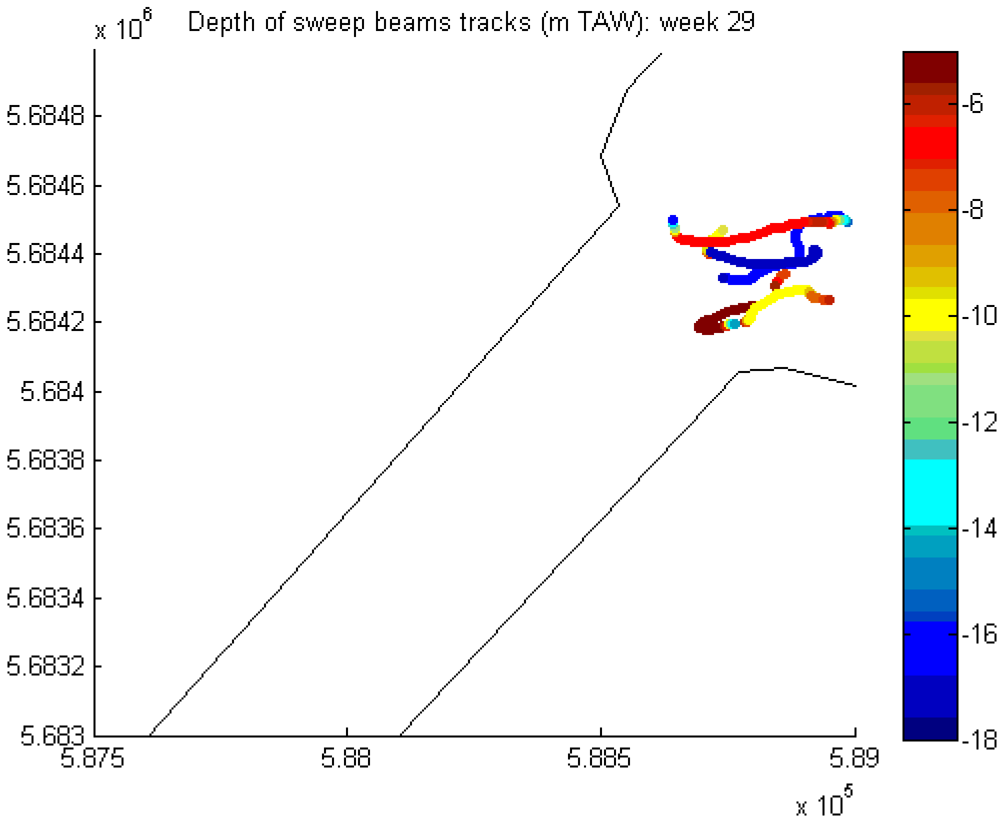
***Total dredged mass in covered area per week (TDS)**		
	20 August 07	***27 August 07***
ZONE	***26 August 07***	***02 September 07***
1	15571	14642
2	15660	14915
3a	10688	10491
3b	4251	3576
3c	0	0
4Na	4147	3193
4Nb	182	100
4Nc	0	0
4Za	2896	2998
4Zb	2883	2029
4Zc	0	0
5Na	2180	1592
5Nb	0	0
5Nc	0	0
5Za	1669	1350
5Zb	2542	1868
5Zc	151	138
Total	62820	56890

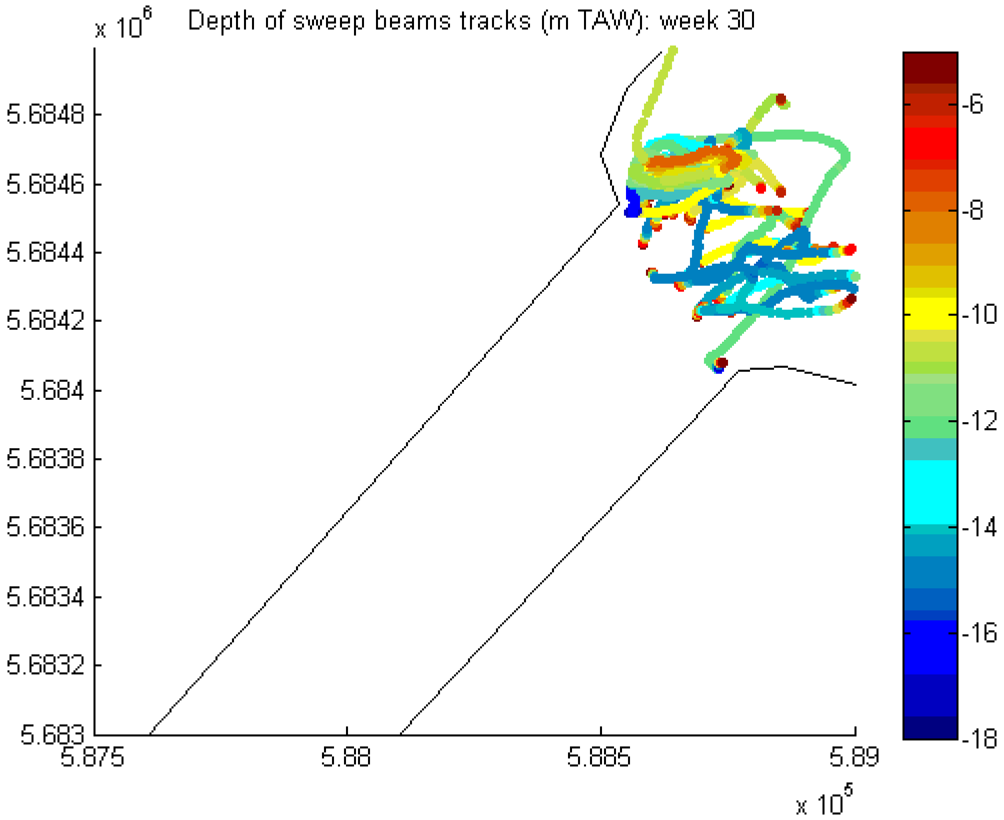
APPENDIX E.

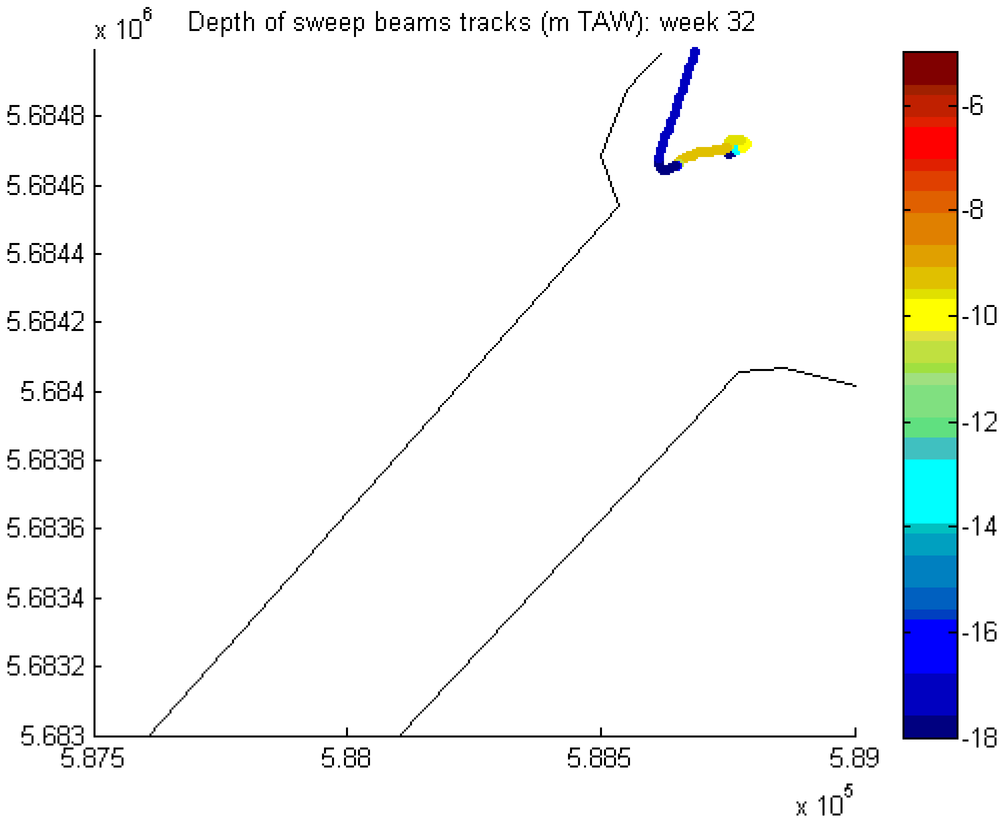
SWEEP BEAM TRACKS

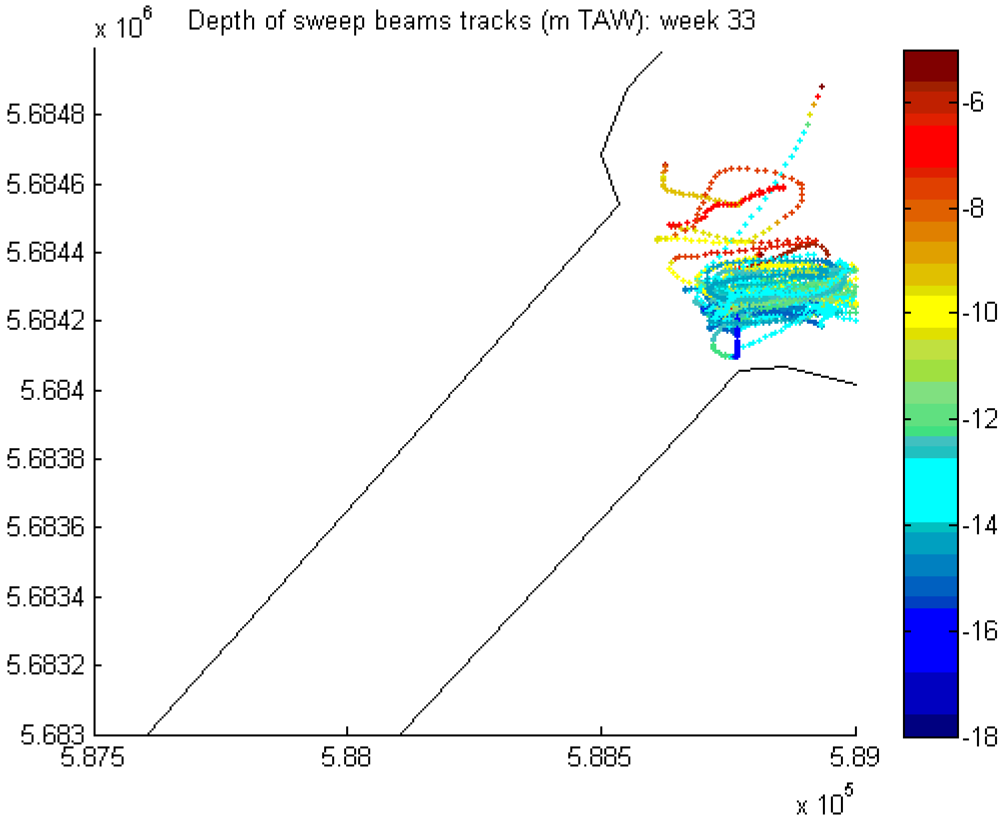
E.1 Depth of sweep beam tracks

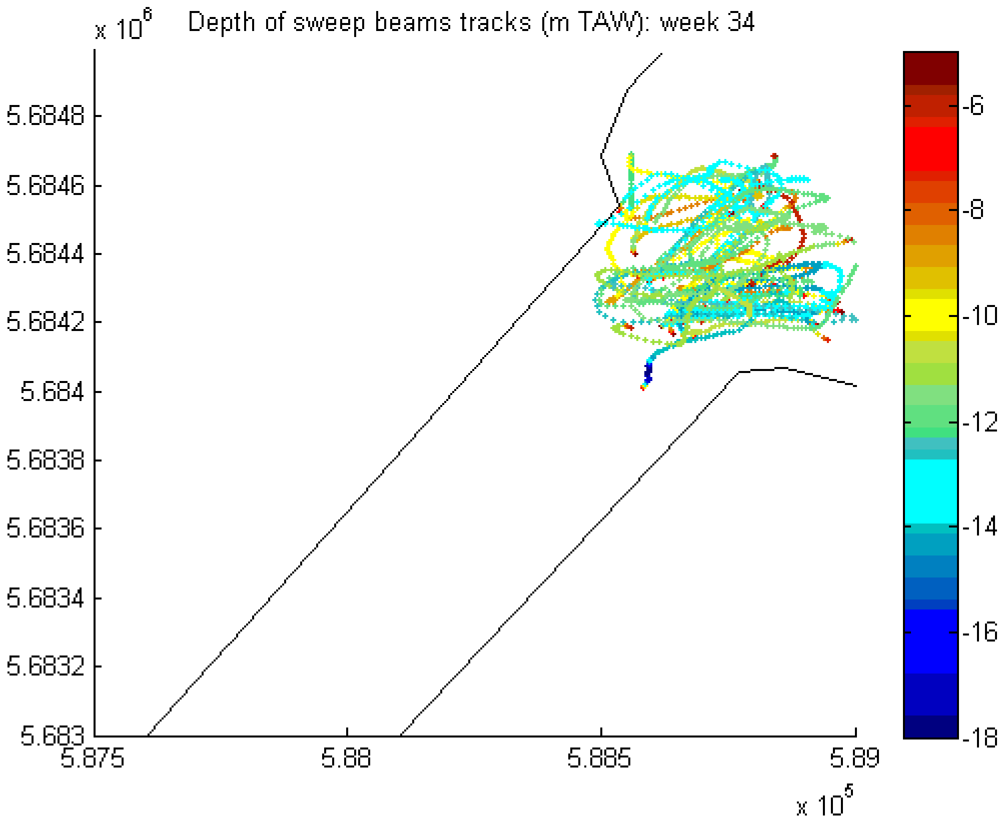

Depth of sweep beams tracks (m TAW): week 27
x 10^6
5.6848
5.6846
5.6844
5.6842
5.684
5.6838
5.6836
5.6834
5.6832
5.683
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18


Depth of sweep beams tracks (m TAW): week 29
x 10^6
5.6848
5.6846
5.6844
5.6842
5.684
5.6838
5.6836
5.6834
5.6832
5.683
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18


Depth of sweep beams tracks (m TAW): week 30
x 10^6
5.6848
5.6846
5.6844
5.6842
5.684
5.6838
5.6836
5.6834
5.6832
5.683
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18

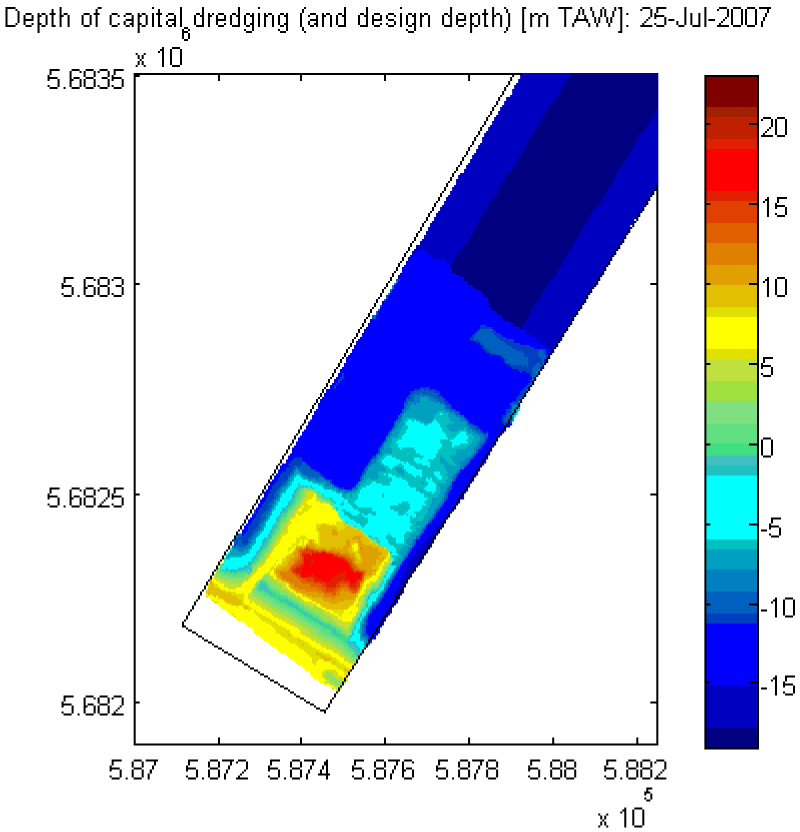

Depth of sweep beams tracks (m TAW): week 32
x 10^6
5.6848
5.6846
5.6844
5.6842
5.684
5.6838
5.6836
5.6834
5.6832
5.683
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18

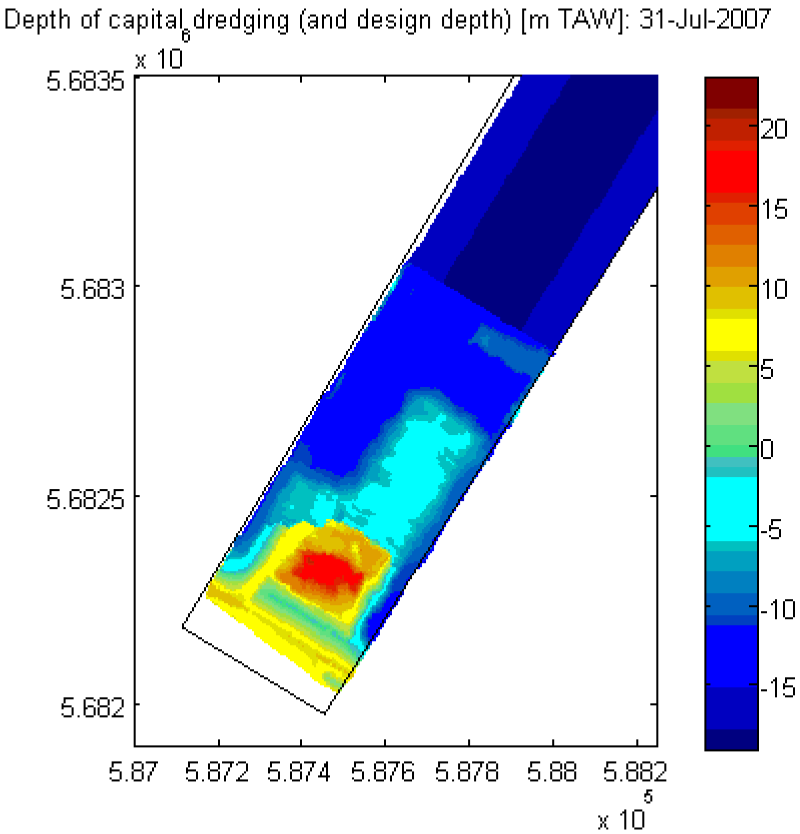

x 10^6
Depth of sweep beams tracks (m TAW): week 33
5.6848
5.6846
5.6844
5.6842
5.684
5.6838
5.6836
5.6834
5.6832
5.683
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18

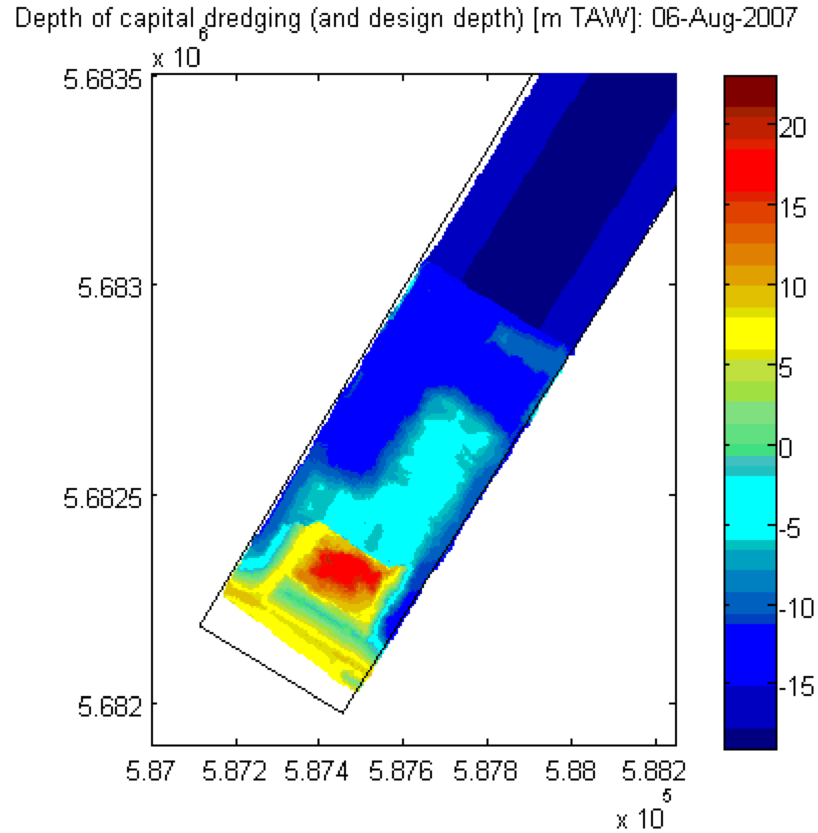

x 10^6
Depth of sweep beams tracks (m TAW): week 34
5.6848
5.6846
5.6844
5.6842
5.684
5.6838
5.6836
5.6834
5.6832
5.683
5.875
5.88
5.885
5.89
x 10^5
-6
-8
-10
-12
-14
-16
-18

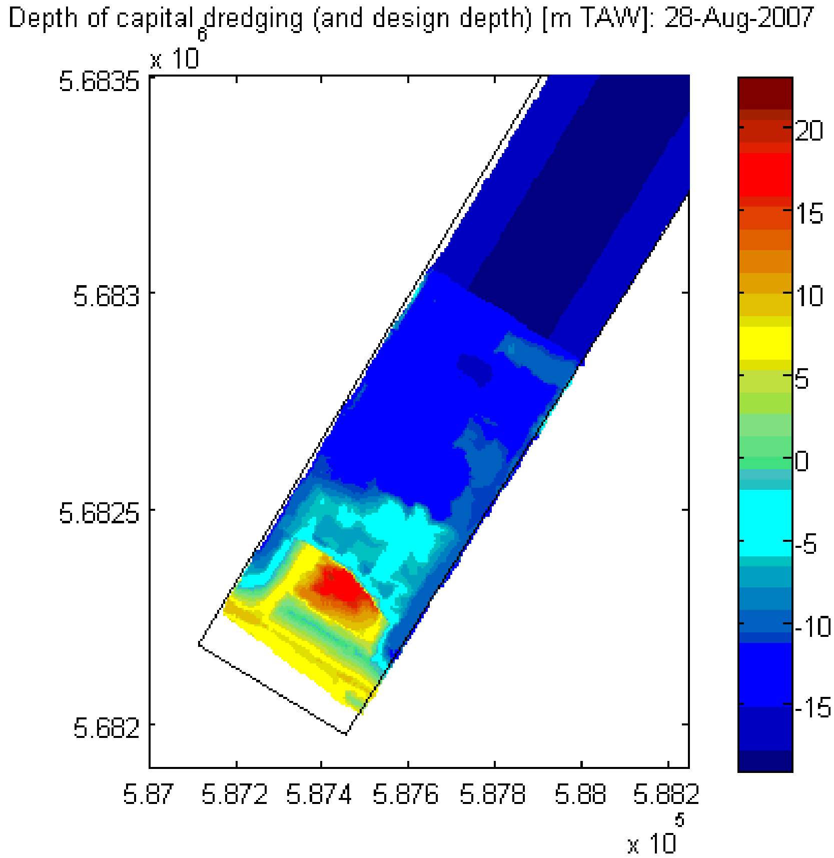
APPENDIX F.

CAPITAL DREDGING PROGRESS


Depth of capital dredging (and design depth) [m TAW]: 25-Jul-2007
x 10^6
5.6835
5.683
5.6825
5.682
5.87
5.872
5.874
5.876
5.878
5.88
5.882
x 10^5
20
15
10
5
0
-5
-10
-15


Depth of capital dredging (and design depth) [m TAW]: 31-Jul-2007
x 10^6
5.6835
5.683
5.6825
5.682
5.87
5.872
5.874
5.876
5.878
5.88
5.882
x 10^5
20
15
10
5
0
-5
-10
-15


Depth of capital dredging (and design depth) [m TAW]: 06-Aug-2007
x 10^6
5.6835
5.683
5.6825
5.682
5.87
5.872
5.874
5.876
5.878
5.88
5.882
x 10^5
20
15
10
5
0
-5
-10
-15


Depth of capital dredging (and design depth) [m TAW]: 28-Aug-2007
x 10^6
5.6835
5.683
5.6825
5.682
5.87
5.872
5.874
5.876
5.878
5.88
5.882
x 10^5
20
15
10
5
0
-5
-10
-15